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[ABSTRACT OF THE DISCLOSURE]

[ABSTRACT]

Disclosed is a channel communication method in a CDMA communication system. The channel communication method comprises the steps of: transmitting a preamble through which a mobile station accesses a base station; allocating in response to the preamble a control channel receiver for receiving channel allocation information and power control information transmitted from the base station, and an uplink common channel transmitter for transmitting a message; and transmitting a message through the uplink common channel transmitter, and controlling transmission power of the uplink common channel transmitter according to the power control information received from the control channel receiver.

[REPRESENTATIVE FIGURE]

FIG. 3

[INDEX]

Common Packet Channel, Collision Detection Preamble, Channel Allocation AICH, Collision Detection AICH, Signature

[SPECIFICATION]

[TITLE OF THE INVENTION]

APPARATUS AND METHOD FOR INDICATING ACQUISITION IN A CDMA COMMUNICATION SYSTEM

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a diagram illustrating structures of uplink and downlink common channels in a CDMA communication system.

FIG. 2 is a diagram illustrating structures of uplink and downlink common channels in a conventional CDMA communication system.

FIG. 3 is a diagram illustrating structures of uplink and downlink common channels in a CDMA communication system, according to an embodiment of the present invention.

FIG. 4 is a diagram illustrating a structure of the preamble shown in FIG. 3.

FIG. 5a is a diagram illustrating a structure of an AICH (Access preamble-acquisition Indicator Channel) frame according to an embodiment of the present invention, and FIG. 5b is a diagram illustrating a structure of an AICH generator for generating an AICH signal.

FIGS. 6a to 6c are diagrams illustrating a channel allocation AICH according to an embodiment of the present invention, and a scheme for generating the same.

FIG. 7 is a diagram illustrating a structure of a mobile station transmitting a message over a common channel in a CDMA communication system, according to an embodiment of the present invention.

FIG. 8 is a diagram illustrating a structure of a base station transmitting a message over a common channel in a CDMA communication system, according to an embodiment of the present invention.

FIG. 9 is a diagram illustrating a scheme for designating a channel by combining a CD (Collision Detection)_AICH with a CA (Channel Allocation)_AICH, according to another embodiment of the present invention.

FIG. 10 is a diagram illustrating another structure of an uplink and downlink

common channel in a CDMA communication system, according to an embodiment of the present invention.

FIG. 11 is a diagram illustrating a scheme for generating a CD/CA_AICH signal in FIG. 10.

FIGS. 12a and 12b are diagrams illustrating a scheme for efficiently transmitting a CD_AICH and a CA_AICH, according to an embodiment of the present invention.

FIG. 13 is a diagram illustrating a structure of a signature used in the AICH.

FIG. 14 is a diagram illustrating a structure of an AICH receiver according to a first embodiment of the present invention.

FIG. 15 is a diagram illustrating a structure of an AICH receiver according to a second embodiment of the present invention.

FIG. 16 is a diagram illustrating a first scheme for allocating plural CPCHs (Common Packet Channels) according to an embodiment of the present invention.

FIG. 17 is a diagram illustrating a second scheme for allocating plural CPCHs according to an embodiment of the present invention.

[DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT]
[OBJECT OF THE INVENTION]
[RELATED FIELD AND PRIOR ART OF THE INVENTION]

The present invention relates generally to a common channel communication apparatus and method for a CDMA communication system, and in particular, to an apparatus and method for communicating data over a common channel in an asynchronous CDMA communication system.

An asynchronous CDMA communication system, such as the UMTS (Universal Mobile Telecommunications System) W-CDMA (Wideband Code Division Multiple Access) communication system, which is a future mobile communication system, uses a random access channel (RACH) for an uplink (or reverse) common channel.

FIG. 1 is a diagram illustrating a communication structure of a conventional

asynchronous uplink common channel. In FIG. 1, reference numeral 151 indicates a structure of an uplink channel, which can be the RACH. Further, reference numeral 111 indicates an operation of an access preamble-acquisition indicator channel (AICH), which is a downlink (or forward) channel.

Referring to FIG. 1, a mobile station transmits a preamble 162 of specific length using the RACH and then awaits a response from a base station. Upon detecting the preamble transmitted over the RACH, the base station transmits a signature 122 of the detected preamble over the downlink AICH. The mobile station then monitors an AICH corresponding to the transmitted preamble. If the mobile station receives the AICH signal, it demodulates the signature 122. In this case, if the signature corresponding to the preamble transmitted over the RACH is detected through the AICH signal, the mobile station judges that the base station has detected the preamble, and transmits a message over the uplink access channel.

Otherwise, upon failure to detect an AICH signal transmitted from the base station within a set time $T_{p\text{-}AI}$ after transmission of the preamble 162, the mobile station judges that the base station has failed to detect a preamble, and retransmits the preamble after a lapse of a preset time. As represented by reference numeral 164, the mobile station retransmits the preamble at transmission power increased by ΔP (dB) from the transmission power at which the preamble was previously transmitted. Upon failure to receive the AICH signal transmitted from the base station after transmission of the preamble, the mobile station changes, after a lapse of a set time, the transmission power of the preamble and repeatedly performs the above operation. If the AICH signal is received during the process of transmitting the preamble, the mobile station transmits, after a lapse of a preset time, an uplink common channel message 170.

As described above, by transmitting the preamble using the RACH, it is possible for the base station to efficiently detect the preamble and to readily set the initial power of the uplink common channel message. However, since the RACH is not power controlled, it is difficult to transmit packet data, which has a large amount of transmission data and a long transmission time.

To solve this problem, a method for power controlling the uplink common channel has been proposed for the W-CDMA system. This method is applied to a common packet channel (CPCH). The CPCH enables power control of the uplink common channel. Accordingly, the CPCH enables the mobile station to transmit a data channel of a high rate for a predetermined time (from one to five hundreds of ms). Further, the CPCH enables the mobile station to rapidly transmit a message, which is smaller in size than a specific value, to the base station using the uplink common channel, without using a dedicated channel. That is, in order to establish the dedicated channel, many related control messages are exchanged between the mobile station and the base station. Therefore, exchanging many control messages in transmitting data of a comparatively small size of several tens to several hundreds of ms, becomes a needlessly large amount of overhead. Thus, it is more effective to use the CPCH, when transmitting data of a small size.

However, since plural mobile stations share the common packet channel, a collision phenomenon between uplink channels should be prevented as far as possible. FIG. 2 shows a signal transmission procedure of the downlink and uplink channel signals according to the prior art. In FIG. 2, a collision detection preamble (CD_P) is used to prevent a collision between uplink channel signals.

Referring to FIG. 2, a mobile station transmits access preambles 262 and 264 to a base station according to the procedure shown in FIG. 1. Upon detection of the access preamble 264, the base station transmits to the mobile station an AICH signal as shown in reference numeral 222. Then, the mobile station receives to demodulate the AICH signal. In this case, it may be judged that the base station has detected a preamble of the mobile station itself, but it may also be judged that the base station has transmitted an ACK signal in response to the same preamble that was transmitted by another mobile station at a similar time to the time when the above mobile station transmitted the preamble. In short, the mobile station cannot determine precisely whether the base station has actually detected the same preamble that the mobile station itself transmitted. Consequently, it may happen that two or more mobile stations simultaneously transmit a message over the same

channel, judging that the base station has received an access preamble transmitted by the mobile stations themselves.

In order to avoid this collision probability, the mobile station transmits a CD preamble 266 to the base station after receiving over the AICH an ACK to the access preamble. That is, after receiving an AICH signal from the base station, the mobile station randomly selects a CD preamble to transmit the selected collision detection preamble to the base station. Upon receipt of the CD preamble after transmission of the AICH signal, the base station transmits a response signal for the CD preamble to the mobile station over another CD_AICH. In this case, if the number of CD preambles to be able to be selected by the mobile station is 16, a probability of a collision between two mobile stations can be decreased by 1/16.

If the mobile station receives from the base station over the CD_AICH an ACK for the CD preamble, it transmits a message to the base station over a CPCH after a lapse of a given time. The CPCH is comprised of power control data and information data, which can transmit a signal of a high data rate over a given time (from several tens to several hundreds of ms), performing power control with one uplink common channel. At the same time, the base station allocates a downlink DPCCH(Dedicated Physical Control Channel) to transmit a power control command to the mobile station as represented by reference numeral 230, and the mobile station outputs the power control command through a CPCH.

As stated above, when transmitting the message over the CPCH, the base station should allocate a downlink channel for power control of the CPCH. In FIG. 2, the downlink channel is assumed to be a DPCCH. Further, the base station should allocate an uplink common packet channel over which the mobile station transmits a message. That is, when allocating the downlink channel for the uplink common packet channel, the base station can allocate a specific downlink channel according to the access preamble or the CD preamble transmitted from the mobile station. In this case, what a base station that manages system resources can judge and control may be inefficient in allocating a channel.

In a method illustrated in FIG. 2, an uplink common channel or a common packet channel is set to be power-controlled for its efficiency, and a CD preamble and an ACK transmitted over a CD_AICH is used so as to decrease a collision of uplink signals. However, in order to efficiently use the common packet channel, downlink and uplink channels should be properly allocated.

The AICH uses a preamble signature of an uplink as that of a downlink. FIG. 13 illustrates signatures of the AICH. In the above process, since a mobile station receiver has only to detect from the AICH only a signature of a preamble that the mobile station receiver itself transmitted, there is no need to consider a complexity of the mobile station receiver in receiving the AICH. However, if the base station can transmit one of several signals over the AICH, the mobile station should perform detection on several signatures. In this case, the AICH should be constructed in consideration of the complexity of the mobile station receiver.

[SUBSTANTIAL MATTER OF THE INVENTION]

It is, therefore, an object of the present invention to provide an apparatus and method for transmitting a message over a common channel in a CDMA communication system.

It is another object of the present invention to provide a downlink acquisition indicator channel (AICH), over which a mobile station receiver can receive an acquisition indicator channel with a low complexity.

It is further another object of the present invention to provide a method for enabling a mobile station to simply detect several signatures transmitted over the downlink acquisition indicator channel.

It is yet another object of the present invention to provide a channel allocation method for performing efficient power control on an uplink common channel for transmitting a message over a common channel in a CDMA communication system.

It is still another object of the present invention to provide a device and method for allocating a channel so as to transmit a message over an uplink common channel in an asynchronous CDMA communication system.

[CONSTRUCTION AND OPERATION OF THE INVENTION]

Preferred embodiments of the present invention will be described herein below with reference to the accompanying drawings.

In a CDMA communication system according to the preferred embodiments of the present invention, in order to transmit a message to the base station over the uplink common channel, the mobile station first transmits a preamble to the base station. Then, after receiving and responding to this preamble, the base station allocates to the mobile station a downlink channel used for controlling transmission power of the uplink common channel used by the mobile station. In this case, after transmitting the preamble to the base station, the mobile station receives a channel allocation message from the base station, transmits a message to the base station over an allocated channel, and additionally controls the transmission power of the uplink common channel according to a power control command received over an allocated downlink channel.

In the above description, it is assumed that the preamble transmitted from the mobile station may be an access preamble (AP) or a collision detection preamble (CD_P), and that the base station generates an AP_AICH and a CD_AICH in response to the AP and the CDP, respectively, and generates a CA_AICH for allocating the above-stated channel after transmitting the CD_AICH. If the mobile station has several access preambles that can be transmitted, a preamble transmitted by the mobile station can be an AP, and the base station generates an AP_AICH in response to the AP and may generate a CA_AICH for allocating the above-stated channel, after transmitting the AP_AICH.

FIG. 3 shows a signal flow between the mobile station and the base station

to establish an uplink common packet channel (CPCH) or an uplink common channel proposed in the preferred embodiments of the present invention. In the preferred embodiments of the present invention, it will be assumed that an uplink common packet channel is used for the uplink common channel. However, a different common channel other than the uplink common packet channel can also be used for the uplink common channel.

Referring to FIG. 3, the mobile station, after time synchronization with the downlink through a downlink broadcasting channel, acquires information related to the uplink common channel or the CPCH. The uplink common channel-related information includes information about the number of spreading codes and signatures used for an access preamble, and AICH timing of the downlink. When the mobile station attempts to transmit a signal over the CPCH, the mobile station first transmits an AP as represented by reference numeral 362. The AP is spread with a unique spreading code of the mobile station, and the spread AP is multiplied by a signature.

In the preferred embodiments of the present invention, one bit of the signature is maintained during a 256-chip period, and the 256-chip period is spread with a designated spreading code of each base station. FIG. 4a illustrates a structure of the preamble.

Referring to FIG. 4a, for the spreading code, a sequence of length 256 can be used, and a long code that is not repeated for a length of a preamble can also be used. In the W-CDMA communication system, an uplink common channel can be divided into an RACH and a CPCH by using different spreading codes (a spreading code for the RACH and another spreading code for the CPCH). In addition, although the same spreading code is used in the W-CDMA communication system, the uplink common channel can be divided into the RACH and the CPCH by using different signatures (a signature for the RACH and another signature for the CPCH).

When the mobile station attempts to transmit data to the base station over the CPCH, the mobile station, after time synchronization with the base station,

transmits the AP to the base station at initial power P0 as represented by reference numeral 362. When detecting the AP of power P0, the base station transmits to the mobile station an ACK signal over an AICH corresponding to the AP. In this case, if the uplink capacity of the base station exceeds a predetermined value or there is no more demodulator, the base station transmits a NAK signal to temporarily discontinue mobile station's transmitting the uplink common channel.

In addition, when the base station fails to detect the AP, the base station cannot send an ACK signal to the AICH such as reference numeral 322. Therefore, in the embodiment of the present invention, it will be assumed that nothing is transmitted to the AICH.

Therefore, after transmission of the AP over an uplink RACH, the mobile station monitors a downlink AICH. At this time, the mobile station demodulates an AICH corresponding to the transmitted AP. If the mobile station fails to receive an AP_AICH from the base station because the base station did not transmit any signal, the mobile station retransmits to the base station the AP at power P1 (= P0 + ΔP) after a given time (tp-p) as represented by reference numeral 364. If the base station transmitted a NAK signal to the mobile station, the mobile station discontinues transmission of an uplink CPCH for a given time and then re-attempts the transmission of the uplink CPCH. Here, the given time can be set to 'tp-p' or other values. However, when detecting the AP, the base station transmits an ACK signal to the mobile station over an AP_AICH as represented by reference numeral 322. At this time, if the mobile station succeeds in receiving the ACK signal over the AP_AICH, the mobile station judges that the base station has acquired a mobile station's signal and proceeds to the next step.

If the mobile station receives the ACK signal over the AP_AICH, the mobile station transmits a CD preamble to the base station over the uplink. There may be several CD preambles, and the mobile station randomly selects to transmit one of the several CD preambles. In the preferred embodiments, it will be assumed that the CD preamble is transmitted using a spreading code different from that of the AP, and that the two spreading codes are discriminated from each other through signatures.

In this case, although a collision phenomenon occurred because two or more mobile stations simultaneously transmitted the AP, a probability that the mobile stations select the same CD preamble can be decreased. That is, if there are a number (N2) of CD preambles, a collision probability decreases to 1/N2.

As stated above, if the mobile station transmits a CD preamble to the base station, the base station detects and demodulates the CD preamble. At this time, if the base station detects the CD preamble, the base station transmits a response signal corresponding to the CD preamble over the downlink, as represented by reference numeral 324. The above response signal of the base station is referred to as a 'CD_AICH'. The CD_AICH informs the mobile station of acquisition of the mobile station's signal by transmitting a signature of the CD preamble over the downlink, as the AP_AICH does. Here, the CD_AICH can be spread using a different orthogonal channelization code from that of the AP_AICH. Therefore, the CD_AICH and the AP_AICH can be transmitted over different physical channels, or can be transmitted over the same physical channel by time dividing one orthogonal channel.

In the preferred embodiments of the present invention, the CD_AICH is transmitted over a different physical channel from that of the AP_AICH. That is, the CD_AICH and the AP_AICH are spread with an orthogonal spreading code of length 256 and transmitted over independent physical channels. In this case, the mobile station can transmit a CPCH at a decreased collision probability by ascertaining the CD_AICH.

After transmitting the CD_AICH as represented by reference numeral 324, the base station transmits to the mobile station a channel allocation command over a CA_AICH after a lapse of a given delay time (tcd-ca). The channel allocation command transmitted through the CA_AICH includes allocation information of a downlink channel allocated for power control of the CPCH. The downlink allocated to power control the CPCH is available in several methods.

First, a downlink shared power control channel is used. A method for controlling transmission power of a channel using the shared power control channel

is disclosed in detail in Korean patent application No. 1998-10394, the contents of which are hereby incorporated by reference. Further, it is possible to transmit a power control command for the CPCH by using the shared power control channel. Allocating the downlink channel may include information about the channel number and the time slot for the downlink shared power control used for power control.

Second, a downlink control channel can be used which is time-divided into a message and a power control command. In the W-CDMA system, this channel is defined to control the downlink shared channel. Even when the data and the power control command is time divided for transmission, the channel information includes the information about the channel number and the time slot of the downlink control channel.

Third, one downlink channel can be allocated to control the CPCH. The power control command and the control command can be transmitted together over this channel. In this case, the channel information becomes a channel number of the downlink channel.

In the preferred embodiments of the present invention, the channel allocation command transmitted over the CA_AICH is transmitted after a given time tcd-ca from the transmission of the CD_AICH. The given time tcd-ca can also be set to 0. Further, it will be assumed that in order to decrease the delay in processing a message from an upper layer, a channel allocation command transmitted over the CA_AICH is transmitted in the same format as the CD_AICH. In this case, if there exist 16 signatures and 16 CPCHs, each CPCH will correspond to a unique one of the signatures. For example, when the base station desires to allocate a 5^{th} CPCH for transmitting a message to the mobile station, the base station transmits a 5^{th} signature corresponding to the 5^{th} CPCH in the channel allocation command.

In the above description, it is assumed that two frames of the CA_AICH frame over which the channel allocation command is transmitted has a length of 20ms and includes 15 slots and each slot is comprised of 20 symbols. The frame for transmitting the preamble (AP and CE preamble) is comprised of 15 slots and each

slot can be comprised of 20 symbols. It will be assumed that one symbol period (or duration) has a length of 256 chips and the AICH is transmitted in only a 16-symbol period.

Therefore, the channel allocation command transmitted as shown in FIG. 3 can be comprised of 16 symbols, and each symbol has a length of 256 chips. Further, each symbol is multiplied by the 1-bit signature and the spreading code and then transmitted over the downlink, and an orthogonal property (or orthogonality) is guaranteed between the signatures.

FIG. 5a illustrates a frame structure of an AICH. As illustrated in FIG. 51, one frame of the AICH is comprised of 15 slots, each of which can transmit 0 or more than 1 of the 16 signatures.

FIG. 5b illustrates an AICH generator for generating a CA_AICH allocation command. As stated above, each slot of the AICH frame allocates a corresponding signature out of the 16 signatures. Referring to FIG. 5b, multipliers 501-516 receive corresponding signatures (orthogonal codes W_1-W_{16}) as a first input and receive acquisition indicators AI_1-AI_{16} as a second input, respectively. Therefore, the multipliers 501-516 multiply the corresponding orthogonal code by the corresponding acquisition indicator AI, respectively, and a summer 520 sums up the outputs of the multipliers 501-516 and outputs the resulting value as an AICH signal.

The base station can transmit the channel allocation command using the AICH generator in several methods that are given below by way of example.

For a first method, one downlink channel is allocated to transmit the channel allocation command over the allocated channel. Transmitting the channel allocation command through the first method is referred to as a CA_AICH. FIG. 6a shows a first exemplary CA_AICH. Reference numeral 611 in FIG. 6a illustrates a transmission frame structure of the CD_AICH for transmitting a response signal for the CD preamble, and reference numeral 613 illustrates a structure of a frame for transmitting the channel allocation command over the CA_AICH after a lapse of a

delay time tcd-ca from the transmission of the CD_AICH

For a second method, the CA_AICH can be transmitted by time dividing slots of the AP_AICH or CD_AICH. FIG. 6a illustrates an exemplary scheme for time dividing and allocating the CD_AICH and the CA_AICH to each slot prior to transmit the allocated AICHs. In the second method, some slots of the AP_AICH and the CD_AICH are used for channel allocation, not for an original use of the AP or the CD preamble.

FIG. 6c illustrates a modified form of the first channel allocation method, implemented by setting the delay time tcd-ca to '0' to simultaneously transmit the CD_AICH and the CA_AICH. The current W-CDMA system spreads one symbol of the AP_AICH with a spreading factor 256 and transmits 16 symbols at one slot of the AICH. The method for simultaneously transmitting the CD_AICH and the CA_AICH can be implemented by using symbols of different lengths. For example, when the possible number of the signatures used for the CD preamble is 16 and a maximum of 16 CPCHs can be allocated, it is possible to allocate the channels of a length of 512 chips to the CA_AICH and the CD_AICH, and the CA_AICH and the CD_AICH each can transmit 8 symbols with a length of 512 chips. Here, by allocating 8 signatures, being orthogonal to one another, to the CD_AICH and the CA_AICH and multiplying the allocated 8 signatures by a sign of +1/-1, it is possible to transmit 16 kinds of the CA_AICH and the CD_AICH. This method is advantageous in that it is not necessary to allocate separate orthogonal codes to the CA_AICH.

As described above, the orthogonal codes having a length of 512 chips can be allocated to the CA_AICH and the CD_AICH in the following method. One orthogonal code W_i of length 256 is allocated to both the CA_AICH and the CD_AICH. For the orthogonal code of length 512 allocated to the CD_AICH, the orthogonal code W_i is repeated twice to create an orthogonal code $[W_i\ W_i]$ of length 512. Further, for the orthogonal code of length 512 allocated to the CA_AICH, an inverse orthogonal code - W_i is connected to the orthogonal code Wi to create an orthogonal code $[W_i - W_i]$. It is possible to simultaneously transmit the CD_AICH

and the CA_AICH without allocating separate orthogonal codes, by using the created orthogonal codes $[W_i\ W_i]$ and $[W_i - W_i]$.

In addition, the existing AICH signature can be used for the AICH of FIG. 6c. FIG. 13 illustrates an AICH defined in the current standard. With regard to the CA_AICH, since the base station designates one of several CPCH channels to the mobile station, the mobile station receiver should attempt detecting several signatures. In the conventional AP_AICH and the CD_AICH, the mobile station would perform detection on only one signature. However, when the CA_AICH according to this embodiment of the present invention is used, the mobile station receiver should attempt detecting all the possible signatures. Therefore, there is required a method for designing or rearranging the structure of signatures for the AICH so as to decrease complexity of the mobile station receiver.

As described above, it will be assumed that the 16 signatures created by multiplying 8 signatures out of 16 possible signatures by the signs (+1/-1) are allocated to the CD_AICH, and the 16 signatures created by multiplying the remaining 8 signatures out of the 16 possible signatures by the signs (+1/-1) are allocated to the CA_AICH for CPCH allocation.

A first embodiment of the present invention uses the signatures shown in FIG. 13 for the AICH signatures and allocates the CA_AICH so that the mobile station receiver may have low complexity. An orthogonal property is maintained between the AICH signatures. Therefore, if the signatures allocated to the AICH are efficiently arranged, the mobile station can easily demodulate the CD_AICH by fast Hadamard transform (FHT).

Let's say that n^{th} signature is represented by Sn and a value determined by multiplying n^{th} signature by a sign '-1' is represented by –Sn. The AICH signatures according to the preferred embodiment of the present invention are allocated as follows.

{S1, -S1, S2, -S2, S3, -S3, S14, -S14,

S4, -S4, S9, -S9, S11, -S11, S15, -S15}

If the number of the CPCHs is smaller than 16, the signatures are allocated to the CPCHs from left to right so as to enable the mobile station to perform FHT, thereby reducing the complexity. If 2, 4 and 8 signatures are selected from {1, 2, 3, 14, 15, 9, 4, 11} from left to right, the number of A's is equal to the number of –A's in each column excepting the last column. Then, by rearranging (or permuting) the sequence of the symbols and multiplying the rearranged symbols by a given mask, the signatures are converted to an orthogonal code capable of performing FHT.

FIG. 14 shows a structure of the mobile station receiver according to an embodiment of the present invention.

Referring to FIG. 14, the mobile station despreads an input signal for a 256-chip period to generate channel-compensated symbol X_i. If it is assumed that X_i indicates an i^{th} symbol input to the mobile station receiver, a position shifter (or permuter) 1423 rearranges X_i as follows.

$$Y = \{X_{15}, X_9, X_{10}, X_6, X_{11}, X_3, X_7, X_1$$
$$X_{13}, X_{12}, X_{14}, X_4, X_8, X_5, X_2, X_0\}$$

A multiplier 1427 multiplies the rearranged value Y by the following mask M generated by a mask generator 1425.

$$M = \{-1, -1, -1, -1, 1, 1, 1, -1, 1, -1, -1, 1, 1, 1, -1, -1\}$$

Then, the signatures of S1, S2, S3, S14, S15, S9, S4 and S11 are converted into S'1, S'2, S'3, S'14, S'15, S'9, S'4 and S'11, as follows.

S'1	=	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S'2	=	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1
S'3	=	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1
S'14	=	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1

S'15	=	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1
S'9	=	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1
S'4	=	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1
S'11	=	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1

It can be understood that, by rearranging the sequence of the input symbols and multiplying the rearranged symbols by a given mask, the signatures are converted to an orthogonal code capable of performing FHT. Further, it is not necessary to perform FHT on the length 16, and it is possible to further decrease the complexity of the receiver by adding the repeated symbols and performing FHT on the added symbols. That is, when 5 to 8 signatures are used (i.e., 9 to 16 CPCHs are used), two symbols are repeated. Thus, if the repeated symbols are added, FHT is performed on only the length 8. In addition, when 3 to 4 signatures are used (i.e., 5 to 8 CPCHs are used), 4 symbols are repeated, so that FHT can be performed after adding the repeated symbols. By efficiently rearranging the signatures in this manner, it is possible to drastically decrease the complexity of the receiver.

The mobile station receiver of FIG. 14 is so constructed as to rearrange the de-spread symbols and then multiply the rearranged symbols by a specific mask M. However, it is possible to obtain the same result even if the de-spread symbols are first multiplied by a specific mask M before rearrangement. In this case, it should be noted that the mask M has a different type.

In operation, a multiplier 1411 receives an output signal of an A/D converter (not shown) and multiples the received signal by a spreading code W_p for the pilot channel to de-spread the received signal. A channel estimator 1413 estimates the size and phase of the downlink channel from the de-spread pilot signal. A multiplier 1417 multiplies the received signal by a Walsh spreading code W_{AICH} for the AICH channel, and an accumulator 1419 accumulates the outputs of the multiplier 1417 for a predetermined symbol period (e.g., 256-chip period) and outputs de-spread symbols. For demodulation, the de-spread AICH symbols are multiplied by the output of a complex conjugator 1415, which complex conjugates the output of the channel estimator 1413. The demodulated symbols are provided to a position shifter

1423, which rearranges the input symbols such that the repeated symbols should neighbor to each other. The output of the position shifter 1423 is multiplied by a mask output from a mask generator 1425 by a multiplier 1427 and provided to an FHT converter 1429. Receiving the output of the multiplier 1427, the FHT converter 1429 outputs signal strength of each signature. A control and decision block 1431 receives the output of the FHT converter 1429 and decides the signature having the highest possibility for CA_AICH. In FIG. 14, it is possible to obtain the same results, although the locations of the position shifter 1423, the mask generator 1425 and the multiplier 1427 are interchanged. Further, even if the mobile station receiver does not rearrange the position of the input symbols using the position shifter 1423, it is also possible to previously appoint the positions at which the symbols are to be transmitted and use the positional information when performing FHT.

Summarizing the embodiment of the CA_AICH signature structure according to the present invention, 2^K signatures of length 2^K are generated. (If the 2^K signatures are multiplied by the signs of +1/-1, the number of the possible signatures can be 2^{K+1}). However, if only some of the signatures are used, rather than all, it is necessary to more efficiently allocate the signatures in order to decrease the complexity of the mobile station receiver. It will be assumed that M signatures out of the whole signatures are used. Herein, $2^{L-1} < M \leq 2^L$ and $1 \leq L \leq K$. The M signatures of length 2^K are converted to the form in which each bit of the Hadamard function of length 2^L is repeated 2^{K-L} times before transmission, when a specific mask is applied to (or exclusive ORed with) the respective bits after permuting the symbols. Therefore, this embodiment aims to simply perform FHT by multiplying the received symbols by a specific mask and permuting the symbols at the mobile station receiver.

The AICH cane be transmitted using another signature that is different from a signature used for a preamble. In this case, the signatures for the AICH use the Hadamard function, which is made in the following format.

$$Hn = \begin{matrix} Hn\text{-}1 & Hn\text{-}1 \\ Hn\text{-}1 & -Hn\text{-}1 \end{matrix}$$

$$H1 = \begin{matrix} 1 & 1 \\ 1 & -1 \end{matrix}$$

Then, the Hadamard function of length 16 required in the embodiment of the present invention is as follows. The signatures created by the Hadamard function show the format given after multiplying the signatures by a channel gain A of the AICH. In this case, 1 and –1 represent A and –A, respectively.

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	=> S1
1	-1	1	-1	1	-1	1	-1	1	-1	1	-1	1	-1	1	-1	=> S2
1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	=> S3
1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	=> S4
1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	=> S5
1	-1	1	-1	-1	1	-1	1	1	-1	1	-1	-1	1	-1	1	=> S6
1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	=> S7
1	-1	-1	1	-1	1	1	-1	1	-1	-1	1	-1	1	1	-1	=> S8
1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	=> S9
1	-1	1	-1	1	-1	1	-1	-1	1	-1	1	-1	1	-1	1	=> S10
1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	=> S11
1	-1	-1	1	1	-1	-1	1	-1	1	1	-1	-1	1	1	-1	=> S12
1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	=> S13
1	-1	1	-1	-1	1	-1	1	-1	1	-1	1	1	-1	1	-1	=> S14
1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	=> S15
1	-1	-1	1	-1	1	1	-1	-1	1	1	-1	1	-1	-1	1	=> S16

Eight of the above Hadamard functions are allocated to the CD_AICH and the remaining eight Hadamard functions are allocated to the CA_AICH. The signatures for the CA_AICH are allocated in the following sequence.

{S1, S9, S5, S13, S3, S11, S15}

Further, the signatures for the CD_AICH are allocated in the following sequence.

{S2, S10, S6, S14, S4, S8, S12, S16}

Here, the signatures for the CA_AICH are allocated from left to right in order to enable the mobile station to perform FHT, thereby minimizing the complexity. When 2, 4 and 8 signatures are selected from the signatures for the CA_AICH from left to right, the number of 1's is equal to the number of -1's in each column except the last column. By allocating the signatures for the CD_AICH and the CA_AICH in the above manner, it is possible to simplify the structure of the mobile station receiver for the number of the used signatures.

In addition, it is possible to associate the signatures to the CPCH or the downlink channel for controlling the CPCH in another format. For example, the signatures for the CA_AICH can be allocated as follows.

[1, 9] => a maximum of 2 signatures are used

[1, 5, 9, 13] => a maximum of 4 signatures are used

[1, 3, 5, 7, 9, 11, 13, 15] => a maximum of 8 signatures are used

If NUM_CPCH (where $1 < \text{NUM\_CPCH} \leq 16$) CPCHs are used, the signs (+1/-1) multiplied by the signatures associated with a k^{th} (k=0, ..., NUM_CPCH-1) CPCH (or a downlink channel for controlling the CPCH) are given as follows.

$$\text{CA\_sign\_sig}[k] = (-1)[k \bmod 2]$$

where CA_sign_sig[k] indicates the sign of +1/-1 multiplied by the k^{th} signature, and [k mod 2] indicates a remainder determined by dividing 'k' by 2. 'x' is defined as a number indicating a dimension of the signatures, which can be expressed as follows.

$$x = \begin{cases} 2 & \text{if} \quad 0 < \text{NUM\_CPCH} \leq 4 \\ 4 & \text{if} \quad 4 < \text{NUM\_CPCH} \leq 8 \\ 8 & \text{if} \quad 8 < \text{NUM\_CPCH} \leq 16 \end{cases}$$

Further, the used signatures are as follows.

$$CA\_sig[k] = (16/x) * \lfloor k/2 \rfloor + 1$$

where $\lfloor y \rfloor$ indicates that the maximum integer which does not exceed 'y'. For example, when 4 signatures are used, they can be allocated as follows.

S1 =>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
S5 =>	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1
S9 =>	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1
S13 =>	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1

As can be appreciated, if the signatures are allocated according to an embodiment of the present invention, the signatures have a format in which the Hadamard codes of length 4 are repeated four times. The mobile station receiver adds the repeated 4 symbols and then takes FHT of length 4, when receiving the CA_AICH, thereby making it possible to highly decrease the complexity of the mobile station.

Furthermore, in the CA_AICH signature mapping, the signature numbers for the respective CPCH are added one by one. In this case, the consecutive $2i^{th}$ and $(2i+1)^{th}$ symbols have opposite signs, and the mobile station receiver subtracts the rear symbol from the front symbol out of the two de-spread symbols, so that it can be regarded as the same implementation.

On the contrary, the signatures for the CD_AICH can be allocated in the following sequence. The easiest way of creating the signatures for the k^{th} CD_AICH is to increase the signature number one by one in the above method for allocating the signatures for the CA_AICH. Another method can be expressed as follow.

$$CD\_sign\_sig[k] = (-1)[k \bmod 2]$$
$$CD\_sig[k] = 2 * \lfloor k/2 \rfloor + 2$$

That is, as described above, the CA_AICH is allocated in the sequence of [2,

4, 6, 8, 10, 12, 14, 16].

FIG. 15 shows a CA_AICH receiving device of the mobile station for the above signature structure. As compared with FIG. 14, there is no position shifter and no mask generator in FIG. 15. That is, in FIG. 15, the signatures are re-designed so that a position converter and a mask generator become unnecessary.

Referring to FIG. 15, a multiplier 1511 multiplies a signal received from an analog-to-digital (A/D) converter by a spreading code W_p for the pilot channel to de-spread the received signal, and provides the de-spread signal to a channel estimator 1513. The channel estimator 1513 estimates the size and phase of the downlink channel from the de-spread pilot channel signal. A complex conjugator 1515 complex conjugates the output of the channel estimator 1513. A multiplier 1517 multiplies the received signal by a Walsh spreading code W_{AICH} for the AICH channel, and an accumulator 1519 accumulates the outputs of the multiplier 1517 for a predetermined symbol period (e.g. 256-chip period) and outputs de-spread symbols. The de-spread symbols are inputted to an FHT converter 1529. The FHT converter 1529 outputs signal strength for each signature. A control and decision block 1531 receives the output of the FHT converter 1529 and decides a signature having the highest possibility for the CA_AICH. As compared with FIG. 14, there is no position shifter and no mask generator in FIG. 15. That is, in FIG. 15, the signatures are re-designed so that the mobile station can perform FHT without using a position converter and a mask generator.

In another embodiment of the present invention, the signature according to a Hadamard function is used for the signature structure for the CA_AICH to simplify the structure of the mobile station receiver. Another allocation method will be described below, which is more efficient than the method for using a part of the signatures for the CA_AICH. Summarizing the embodiment of the CA_AICH signature structure according to the present invention, 2^K signatures of length 2^K are generated. (If the 2^K signatures are multiplied by the signs of +1/-1, the number of the possible signatures can be 2^{K+1}). However, if only some of the signatures are used, rather than all, it is necessary to more efficiently allocate the signatures in

order to decrease the complexity of the mobile station receiver. It will be assumed that M signatures out of the whole signatures are used. Herein, $2^{L-1} < M \leq 2^L$ and $1 \leq L \leq K$. The M signatures of length 2^K are converted to the form in which each bit of the Hadamard function of length 2^L is repeated 2^{K-L} times before transmission.

It is also important to allocate channels used in an uplink common control channel.

First, the easiest method for allocating the uplink common channel is to allocate a downlink control channel over which the base station transmits power control information and an uplink common control channel over which the mobile station transmits a message, on a one-to-one basis. When the downlink control channel and the uplink common control channel are allocated on a one-to-one basis, it is possible to allocate the downlink control channel and the uplink common control channel by transmitting a command only once without a separate message. That is, this channel allocation method is applied when the CA_AICH designates the channels used for both the downlink and the uplink.

A second method maps the uplink channel to the function of the signatures for the AP, the slot number of the access channel and the signatures for the CD_P, transmitted from the mobile station. For example, the uplink common channel is associated with an uplink channel corresponding to a slot number at a time point when the signature for the CD_P and its preamble are transmitted. That is, in this channel allocation method, the CD_AICH allocates the channel used for the uplink, and the CA_AICH allocates the channel used for the downlink. If the base station allocates the downlink channel in this method, it is possible to maximally utilize the resources of the base station, thereby increasing utilization efficiency of the channels.

FIG. 7 shows a structure of the mobile station for communicating a message over an uplink common channel according to an embodiment of the present invention.

Referring to FIG. 7, an AICH demodulator 711 demodulates AICH signals

on the downlink transmitted from the AICH generator of the base station, according to control operation of the controller 720. The AICH demodulator 711 may include an AP_AICH demodulator, a CD_AICH demodulator and a CA_AICH demodulator. In this case, the controller 720 designates the channels of the respective demodulators to enable them to receive AP_AICH, CD_AICH and CA_AICH, respectively, transmitted from the base station. The AP_AICH, CD_AICH and CA_AICH can be implemented through either one demodulator or separate demodulators. In this case, the controller 720 can designate the channels by allocating the slots to receive the time-divided AICHs.

A data and control signal processor 713 designates a channel under the control of the controller 720, and processes data or a control signal (including a power control command) received over the designated channel. A channel estimator 715 estimates strength of a signal received from the base station over the downlink, and controls phase compensation and gain of the data and control signal processor 713 to assist demodulation.

The controller 720 controls the overall operation of a downlink channel receiver and an uplink channel transmitter of the mobile station. In this embodiment of the present invention, the controller 720 controls generation of the access preamble AP and the collision detection preamble CD_P while accessing the base station, and processes the AICH signals transmitted from the base station. That is, the controller 720 controls the preamble generator 731 to generate the access preamble AP and the collision detection preamble CD_P as shown by 351 of FIG. 3, and controls the AICH demodulator 711 to process the AICH signals generated as shown by 311 of FIG. 3.

The preamble generator 731, under the control of the controller 720, generates the preambles preamble and CD_P as shown by 351 of FIG. 3. A frame formatter 733 formats frame data by receiving the preambles preamble and CD_P output from the preamble generator 731, and the packet data and pilot signals on the uplink. The frame formatter 733 controls transmission power of the uplink according to the power control signal outputted from the controller 720. In the preferred

embodiment of the present invention, a channel outputting the encoded packet data may be an uplink CPCH. In this case, it is also possible to transmit a power control command for controlling transmission power of the downlink over the uplink.

FIG. 8 shows a transceiver of the base station for communicating a message over an uplink CPCH according to an embodiment of the present invention.

Referring to FIG. 8, an AICH detector 811 detects the preamble and the CD_P shown by 331 of FIG. 3, transmitted from the mobile station, and provides the detected preamble and CD_P to the controller 820. A data and control signal processor 813 designates a channel under the control of the controller 820, and processes data or a control signal received over the designated channel. A channel estimator 815 estimates strength of a signal received from the mobile station over the downlink, and controls a gain of the data and control signal processor 813.

The controller 820 controls the overall operation of a downlink channel transmitter and an uplink channel receiver of the base station. The controller 820 controls detection of the access preamble AP and the collision detection preamble CD_P generated when the mobile station accesses the base station, and controls generation of the AICH signals for responding to the preamble and CD_P and commanding channel allocation. That is, the controller 820 controls the AICH generator 831 using an AICH generation control command 826 to generate the AICH signals shown by 311 of FIG. 3, upon detecting the access preamble AP and the collision detection preamble CD_P received through the preamble detector 811 as shown by 351 of FIG. 3.

The AICH generator 831, under the control of the controller 820, generates AP_AICH, CD_AICH and CA_AICH that are response signals to the preamble signals. The AICH generator 831 may include an AP_AICH generator, a CD_AICH generator and a CA_AICH generator. In this case, the controller 820 designates the generators so as to generate the AP_AICH, CD_AICH and CA_AICH shown by 311 of FIG. 3, respectively. The AP_AICH, CD_AICH and CA_AICH can be implemented by either one generator or separate generators. In this case, the

controller 820 can allocate the time-divided slots of the AICH frame so as to transmit the AP_AICH, CD_AICH and CA_AICH.

A frame formatter 833 formats frame data by receiving the AP_AICH, CD_AICH and CA_AICH output from the AICH generator 831, and the downlink control signals, and controls transmission power of the uplink according to the power control command 824 outputted from the controller 820. Further, when a downlink power control command 832 is received over the uplink, the frame formatter 833 may control transmission power of a downlink channel for controlling the common packet channel according to the power control command.

In the above embodiment of the present invention, only one CPCH can be allocated to one slot. That is, although signatures allocating the respective channels of the CA_AICH are orthogonal to one another, the mobile station cannot know which signature it has received. To solve this problem, a new signature structure can be used, in which plural CPCHs can be allocated to one slot. In this structure, the base station transmits CA_AICH information to the mobile station while transmitting the CD_AICH.

In an embodiment of the present invention, it is assumed that the CA_AICH allocates two CPCHs to the CD_AICH at one time. When transmitting the CD_AICH, the base station multiplies the CD_AICH by one of +1, 0 and –1. More specifically, the base station multiplies the CD_AICH by 0 when it has not detected a CD preamble of the mobile station, and the base station multiplies the CD_AICH by +1 or -1 when it has detected the CD preamble of the mobile station.

The information +1/-1 can be used for designating the CA_AICH. That is, while multiplying the CD_AICH by +1 before transmission, the base station multiplies the CA_AICH of a corresponding mobile station by +1 prior to transmission. Similarly, while multiplying the CD_AICH by -1 before transmission, the base station multiplies the CA_AICH of the corresponding mobile station by -1 prior to transmission. Then, the mobile station detects a pattern at which the base station multiples the CD_AICH by +1/-1, and selects and uses a channel

corresponding to the detected pattern, out of channels determined according to a channel allocation command transmitted over the CA_AICH. That is, if the mobile station has detected a pattern of -1 from the CD_AICH, it receives a channel multiplied by −1, out of the channels determined according to a channel allocation command transmitted over the CA_AICH. Otherwise, if the mobile station has detected a pattern of +1 from the CD_AICH, it receives a channel multiplied by +1. In this manner, two channels can be simultaneously allocated to one AICH.

According to the above method, up to two CPCHs can be allocated to one slot. However, this object can be embodied through other ways. FIG. 16 illustrates a first exemplary scheme for allocating plural CPCHs according to an embodiment of the present invention. The process of transmitting an acquisition preamble, an acquisition AICH and a CD preamble, which is performed before the CD_AICH and the CA_AICH in FIG. 16, is identical to that of FIG. 3. The τcd-ca shown in FIG. 16 indicates a time delay between the CD_AICH and the CA_AICH. The CD_AICH and the CA_AICH can also be transmitted simultaneously by setting τcd-ca to 0.

As illustrated in FIG. 16, several orthogonal functions are allocated to the CD_AICH. That is, several orthogonal codesW1, W2, ..., WN are allocated to the CD_AICH. In addition, the mobile station is beforehand informed of how many CD_AICHs can be simultaneously transmitted. When the base station attempts to transmit M (0<M<=N) CD_AICHs at once, it transmits CD_AICHs to M orthogonal codes out of N CD_AICHs. For example, when the mobile station attempts to allocate two CPCHs, it transmits different CD_AICHs to two orthogonal codes W1 and W2. In this case, an orthogonal code for transmitting the CD_AICH and an orthogonal code for transmitting the CA_AICH are agreed in advance between the base station and the mobile station. For example, when the CD_AICH is transmitted to W1, the CA_AICH is transmitted to WN+1, and when the CD_AICH is transmitted to W2, the CA_AICH is transmitted to WN+2. The mobile station demodulates all the orthogonal codes W1, W2, ..., WN and ascertains whether the base station has transmitted the CD_AICH transmitted by the mobile station itself. If the mobile station has received a signature of the CD_AICH that it should receive, the mobile station can know CPCH information allocated to the mobile station itself

by demodulating the orthogonal channel of the agreed CA_AICH. For example, when the mobile station has received the CD_AICH transmitted from W2 to the mobile station itself, the mobile station will receive CPCH information transmitted the agreed WN+2 channel.

FIG. 17 illustrates a second exemplary scheme for allocating plural CPCHs according to an embodiment of the present invention. In FIG. 17, one orthogonal channel is allocated to the CD/CA_AICHs. In this case, by properly distributing signatures, a signature can be allocated to the CD_AICH, and another signature can be allocated to the CA_AICH. That is, the CD_AICH and the CA_AICH are simultaneously transmitted through one orthogonal channel. Several orthogonal channels are allocated to this AICH. Several CD/CA_AICHs are transmitted through each orthogonal channel. That is, a signal for allocating several CPCHs is transmitted through one slot. The mobile station receives the AICH transmitted through several orthogonal channels and ascertains where there is any CD_AICH transmitted to the mobile station itself. If there is no CD_AICH transmitted to the mobile station itself, it retransmits the CD_AICH, judging that the base station did not allocated the CPCH. Otherwise, if the CPCH has been transmitted through one orthogonal channel, the mobile station transmits the CPCH by receiving the CA_AICH transmitted through the orthogonal channel.

Through the above method, several CPCHs can be allocated to one slot. The base station informs through a broadcasting channel the mobile station how many CPCHs can be allocated to one slot. In addition, the base station can inform the mobile station of orthogonal codes used for the CD_AICH and the CA_AICH. The mobile station performs demodulation on all the available CD_AICHs by receiving the CPCH allocation information transmitted through the broadcasting channel. If the mobile station has received a CD_AICH signature transmitted to the mobile station itself, the motile station obtains CPCH-related information allocated to the mobile station itself by demodulating the CA_AICH transmitted through an orthogonal code corresponding to the received CD_AICH.

In order to allocate several CPCHs to one slot as stated above, the base

station should transmit several AICHs and the mobile station should receive signals transmitted through several channels. That is, the mobile station should have several receivers for demodulating and detecting the signals transmitted through the several AICHs. However, this will significantly increase a complexity of the mobile station. However, if orthogonal codes allocated to several AICHs are efficiently designed, the AICH can be detected without significantly increasing the complexity of the mobile station receiver. For example, let's assume that one AICH symbol has a length of 256 chips. When two AICHs should be allocated, an orthogonal code Wi of a 128-chip length is allocated to the AICH, and two orthogonal codes [Wi Wi] and [Wi –Wi] of a 256-chip length are allocated to the respective AICHs. The mobile station can generate reception symbols of the respective AICH by de-spreading the orthogonal code of a 128-chip length and performing addition and subtraction on the de-spread results on a two-symbol unit basis. When four AICHs should be allocated, an orthogonal code Wk of a 64-chip length is allocated to the AICH, and four orthogonal codes [Wk Wk Wk Wk], [Wk -Wk Wk -Wk], [Wk Wk -Wk -Wk] and [Wk -Wk -Wk Wk] are allocated to the respective AICHs. The mobile station de-spreads an input signal with the orthogonal code Wk of a 64-chip length before reception. If four successive de-spread symbols are assumed to be x1, x2, x3 and x4, then the outputs of the respective channels are as follows.

$$Y1 = x1 + x2 + x3 + X4$$
$$Y2 = x1 - x2 + x3 - X4$$
$$Y3 = x1 + x2 - x3 - X4$$
$$Y4 = x1 - x2 - x3 + X4$$

where Y1, Y2, Y3 and Y4 represent de-spread symbols corresponding to four AICH.

In addition, information +1/-1 of the CD_AICH can also be used for channel allocation. FIG. 9 illustrates an exemplary scheme for using the information +1/-1 of the CD_AICH for channel allocation. In FIG. 9, it is assumed that 8 CPCHs can be simultaneously transmitted. However, the number of CPCHs that can be simultaneously transmitted may be varied according to circumstances.

Referring to FIG. 9, 8 downlink control channels are divided into two groups A and B as represented by reference numerals 911 and 913. If the CD_AICH is multiplied by +1 before transmission, one of four channels in a group A is selected as a downlink control channel. If the CD_AICH is multiplied by -1 before transmission, one of four channels in a group B is selected as a downlink control channel. A channel allocation method shown in FIG. 9 can reduce by half the length of the CA_AICH that can transmit a channel allocation command through orthogonal signatures. Here, the channel number of the CPCH can be designated in one-to-one correspondence with a downlink channel so that designation of the downlink channel results in designation of an uplink channel, or can be designated through a function of an AP, a CD_P and an access slot number. In addition, the number of CPCHs and the symbol length of the CA_AICH are respectively set to '8' and '4 bits', so that the CA_AICH and the CD_AICH shown in FIG. 6 can be used through a time division technique.

In addition, CD_AICH signs can be used for other purposes. CD_AICH signs +1/-1 can be used for informing the mobile station of whether the CA_AICH has been transmitted. That is, a downlink channel and an uplink common packet channel are mapped through a given function when the mobile station transmits the AP and the CD_P. An uplink CPCH and a downlink channel for controlling the uplink CPCH are promised in advance using the preamble transmitted from the mobile station and a function of a transmission time. The base station can know the promised channels through information on the preamble and the transmission time. By detecting the preamble of the mobile station, the base station can know the promised uplink CPCH and downlink channel and can know whether other users already occupy the corresponding channels. If other users already occupy the promised uplink CPCH and downlink channel, the base station transmits a channel allocation command (CA_AICH). Otherwise, the base station does not transmit the channel allocation command (CA_AICH), but use the promised uplink CPCH and downlink channel. That is, if the promised CPCH and downlink channel is available, the base station transmits a CD_AICH multiplied by +1 and does not transmit the CA_AICH. If the promised CPCH and downlink channel is unavailable, the base station transmits a CD_AICH multiplied by –1, and the CA_AICH. In this case, the

uplink CPCH is transmitted through a channel allocated by the CA_AICH. As stated above, since the CA_AICH is transmitted only when other users already occupy the promised channels, a probability that the CA_AICH is transmitted can be decreased.

If the mobile station detects a sign +1 from the CD_AICH transmitted from the base station, it uses the promised channels. Otherwise, if the mobile station detects a sign -1 from the CD_AICH transmitted from the base station, it does not use the promised channels, but wait a CA_AICH from the base station. Then, after reception of the CA_AICH from the base station, the mobile station transmits data over downlink and uplink CPCHs allocated by the base station.

In the preferred embodiments of the present invention, a new downlink channel is allocated for the CA_AICH in transmitting the CA_AICH, or the CA_AICH and the CD_AICH are transmitted using a time division technique. However, the CA_AICH can be transmitted to the previous position of the CD_AICH. That is, the CA_AICH is transmitted through a slot following the CD_AICH. According to this method, the CA_AICH can be transmitted without allocating a separate channel to the downlink. However, in this case, there is a possibility that another mobile station, which has transmitted an access preamble through another access slot, will mistake the CA_AICH for the CD_AICH. This problem can be solved through the following methods.

In a first method, the CD_AICH is transmitted using a signature multiplied by a sign +1, and the CA_AICH is transmitted using a signature multiplied by a sign –1. Then, by detecting a sign of the signature, the mobile station determines whether a transmitted AICH is the CD_AICH or the CA_AICH. In this case, if the CA_AICH is not identical with the CD_AICH, the CA_AICH and the CD_AICH can be simultaneously transmitted.

In a second method, if the CD_AICH seems to be transmitted, the base station does not transmit an AICH for the AP or the CD_P of the next access slot. In this case, since only a mobile station that has received the AICH are to receive the CD_AICH, mobile stations will not mistake the CA_AICH for the CD_AICH.

However, if the CD_AICH are frequently transmitted, a case where the base station cannot transmit the AICH will occur frequently. Therefore, in order to this problem, it is preferable to reduce a CD_AICH transmission frequency. To reduce the CD_AICH transmission frequency, the CD_AICH is transmitted only when other users occupy the promised channel. That is, as stated above, the base station informs the mobile station of whether the CA_AICH has been transmitted. In this manner, channel allocation can be successfully performed without allocating a separate channel to the CD_AICH.

In the preferred embodiments of the present invention, by transmitting the CA_AICH after transmission of the CD_AICH or simultaneously transmitting the CA_AICH and the CD_AICH, a collision probability of the uplink CPCH can be decreased and the channel allocation can be efficiently performed. However, in the above two method, the CD_AICH and the CA_AICH are separately transmitted.

FIG. 10 illustrates a scheme for collectively transmitting a CD_AICH and a CA_AICH through one AICH. That is, when detecting a CD_P transmitted from the mobile station, the base station transmits one signature over a downlink AICH by combining CD_AICH information and CA_AICH information. In FIG. 10, an AICH that the base station transmits to the mobile station when detecting the CD_P is called a CD/CA_AICH. FIG. 10 shows a method of transmitting the CD/CA_AICH from the base station to the mobile station when the base station detects the CD_P. In this case, the CD_AICH and the CA_AICH are collectively transmitted through one signature.

The signature of the CD/CA_AICH shown in FIG. 10 can be generated from a CD/CA_AICH generator shown in FIG. 11.

Referring to FIG. 11, the base station generates one signature by combining the detected CD_P signature with the CA information. In the preferred embodiments of the present invention, it is assumed that 16 CD signatures and 16 CPCHs are available. Therefore, 256 information combinations are available, which can be regarded as 8-bit information. A signature encoder 1111 receives the 8-bit

information and generates a signature of a 16-symbol length. A multiplexer (MUX) 1113 multiplexes CD/CA signatures corresponding to the respective slots generated from the signature encoder 1111. A multiplier 1113 spreads the output of the MUX 1113 with an orthogonal code Wcd/ca allocated to the CD/CA_AICH. A multiplier 1117 re-spreads the orthogonally-spread signal from the multiplier 1113 with a downlink spreading code to transmit the re-spread signal over the downlink.

One slot of the AICH corresponds to a 20-symbol period. However, in reality, signatures are transmitted only for a 16-symbol period of the 20-symbol period. In FIG. 11, it is assumed that the CD/CA signatures are transmitted only for the 16-symbol period. However, in order to maximize an encoding gain, the signatures can be transmitted during the whole 20-symbol period using an (20,8) encoder.

At this time, the mobile station receives the CD/CA_AICH to perform a test on the signature corresponding to the CD_P transmitted by the mobile station itself. Here, although the number of signatures that the base station can transmit is 256, the mobile station does not need to perform detection on all the signatures because it already knows the expected value of the CD. That is, the mobile station only needs to detect 16 signatures corresponding to the CD_P transmitted by the mobile station itself. Then, upon detection of the CD and a channel allocation command, the mobile station transmits an uplink CPCH after a lapse of given time using a designated channel.

FIGS. 6a and 6b illustrate an embodiment of transmitting the CA_AICH. FIG. 6a shows a case where a new channel is allocated for the CA_AICH. FIG. 6b illustrates a case where the previous AICH and the CA_AICH are transmitted through a time division technique. FIGS. 12a and 12b illustrates an exemplary scheme for efficiently transmitting the CD_AICH and the CA_AICH.

In FIG. 6a, a mobile station receiver, after reception of the CD_AICH, should change an orthogonal code of the receiver so as to receive the CD_AICH. In FIG. 12a, one orthogonal code channel is allocated for transmission of the

CD_AICH and the CA_AICH, which are transmitted by allocating different AICHs to the even-numbered access slots and the odd-numbered access slots. That is, the base station allocates two channels for transmission of the CD_AICH and the CA_AICH, uses a first CD/CA_AICH for transmission of the CD_AICH and the CA_AICH for the odd-numbered access slots, and uses a second CD/CA_AICH for transmission of the CD_AICH and the CA_AICH for the even-numbered access slots. If the mobile station transmitted an AP to the odd-numbered slot, it receives the CD_AICH and the CA_AICH from the first CD/CA_AICH. Otherwise, if the mobile station transmitted an AP to the even-numbered slot, it receives the CD_AICH and the CA_AICH from the second CD/CA_AICH. In FIG. 12a, the CD_AICH and the CA_AICH are successively transmitted to one mobile station. However, they can be transmitted at an interval of several symbols.

FIG. 12b illustrates a case where the CD_AICH and the CA_AICH shown in FIG. 12a are collectively transmitted through one CD/CA_AICH signature. The base station allocates two channels for transmission of the CD/CA_AICH, uses a first CD/CA_AICH for transmission of the CD/CA_AICH for the odd-numbered access slots, and uses a second CD/CA_AICH for transmission of the CD/CA_AICH for the even-numbered access slots.

In the above method, the base station collectively allocates CPCH-related resources such as a downlink control channel and a common packet channel. A description will be made of another embodiment for performing channel allocation as stated above. In this embodiment, the mobile station transmits an AP, and the base station transmits an AP_AICH as in the above method. However, a CD_P that the mobile station can transmit is allocated to two channels. That is, two downlink control channels can be allocated to each CD_P. Here, an uplink CPCH can correspond to the downlink control channel on a one-to-one basis.

Referring to the above embodiment, if the mobile station has transmitted a CP_P, it can be know in advance that the mobile station uses one of two channels allocated to the CD_P. Similarly, when detecting the CD_P, the base station can know which channel the mobile station will use. That is, the mobile station can use

one of the two channels corresponding to the CD_P.

At this time, the base station judges which of the two channels is available, and can allocate a channel to the CD_AICH using information of +1/-1. Here, "+1" indicates a first channel of the two channels, and "-1" indicates a second channel of the two channels. If the two channels are all available, the base station transmits a random one of "+1/-1". However, if only one of the two channels is available, the base station transmits a CD_AICH multiplied by +1/-1 information corresponding to the available channel. If the two channels are all unavailable, the base station a CD_AICH multiplied by 0. This means that the base station has not transmitted any signal.

Then, the mobile station detects the CD_AICH to transmit a CPCH over a channel corresponding to +1/-1. Upon failure to detect the CD_AICH, the mobile station judges that the base station has failed to detect a CD or there is no available channel, and retries to transmit the CPCH after a lapse of a given time.

In the embodiments of the present invention, the base station transmits a channel allocation command through a signature in response to the preamble transmitted from the mobile station. That is, the channel allocation command is a command that the base station transmits for designation of a downlink channel and an uplink CPCH. However, a data rate of the CPCH can also be transmitted through the channel allocation command.

The mobile station and the base station settle in each preamble a data rate of a CPCH in advance. That is, the mobile station transmits different preambles according to the data rate. Although there are radio resources such as a downlink channel and an uplink channel, there may occur a case where the base station cannot provide a service of the data rate corresponding to the preamble transmitted from the mobile station. In addition, there is a case where the base station can support a service of a data rate higher than the data rate corresponding to the preamble transmitted from the mobile station. In this case, the base station can also transmit data rate information through the channel allocation command. That is, a channel

allocation signature transmitted by the base station may be one signature determined through a combination of channel allocation information and an uplink CPCH data rate.

[EFFECTS OF THE INVENTION]

As described above, the conventional CPCH is designed on the assumption that a mobile station selects a random signature and uses a CPCH corresponding to the selected signature. However, this method cannot efficiently manage CPCH-related resources. To solve this problem, the preferred embodiment of the present invention proposes a method for collectively managing and allocating, in a base station, the CPCH-related resources. Consequently, the CPCH-related resources can be efficiently used through a channel allocation scheme according to the preferred embodiments of the present invention.

[PATENT CLAIMS]

1. A common channel communication method of a base station in a CDMA (Code Division Multiple Access) communication system, the method comprising the steps of:

allocating at least two orthogonal codes to a collision detection-acquisition indicator channel (CD_AICH) in one slot;

transmitting different CD_AICHs to the first orthogonal codes; and

transmitting a channel allocation-acquisition indicator channel (CA_AICH) to second orthogonal codes corresponding to the first orthogonal codes.

2. A common channel communication method of a mobile station in a CDMA communication system, which allocates at least two orthogonal codes to a CD_AICH in one slot, the method comprising the steps of:

receiving and demodulating different CD_AICHs spread with at least two first orthogonal codes; and

de-spreading and demodulating a CA_AICH spread with a second orthogonal code corresponding to the first orthogonal code, when detecting in the demodulation process a CD_AICH corresponding to the mobile station.

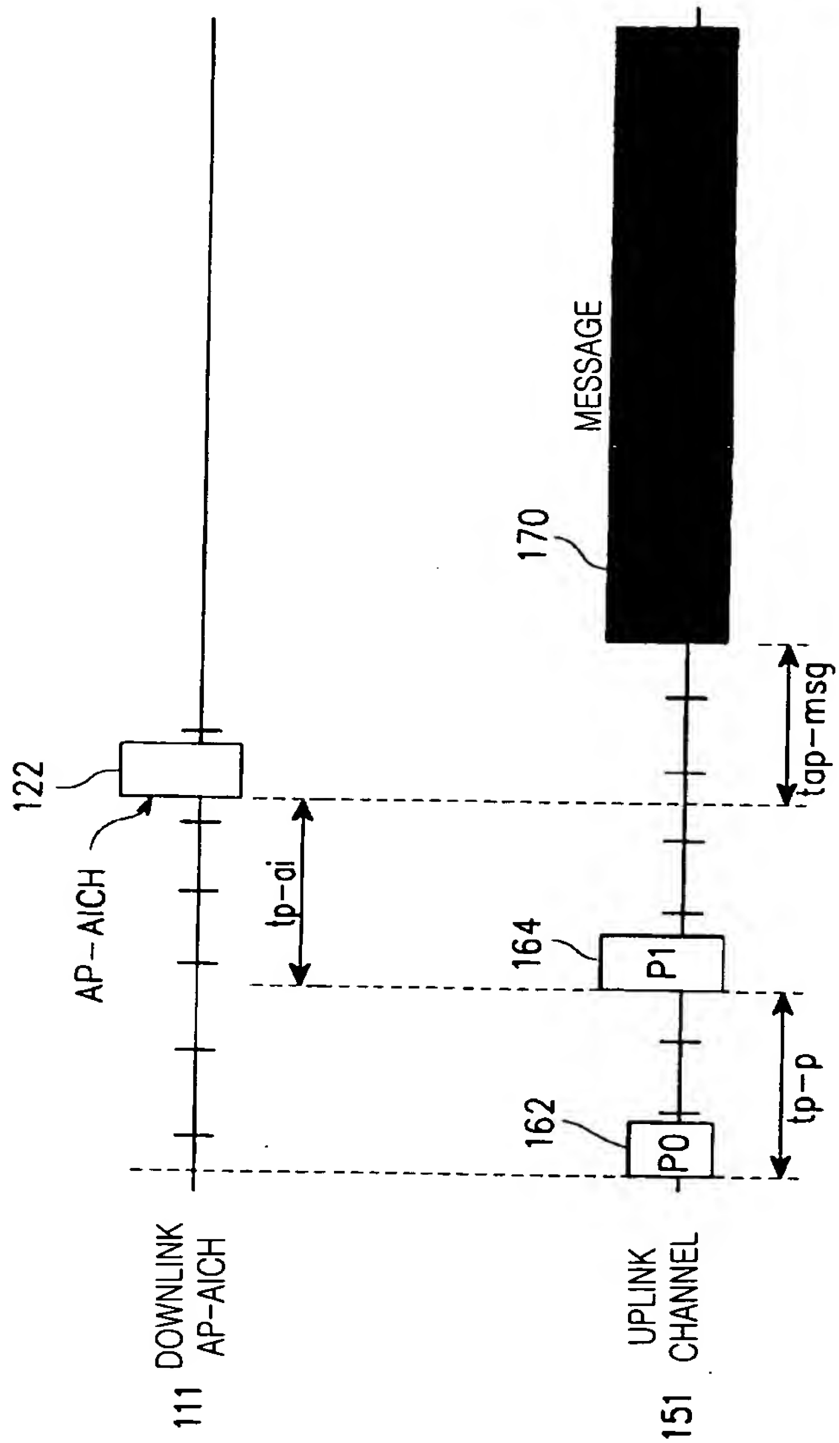

111 DOWNLINK AP-AICH
151 UPLINK CHANNEL
122
AP-AICH
tp-ai
162
P0
164
P1
tp-p
tap-msg
170
MESSAGE

FIG.1

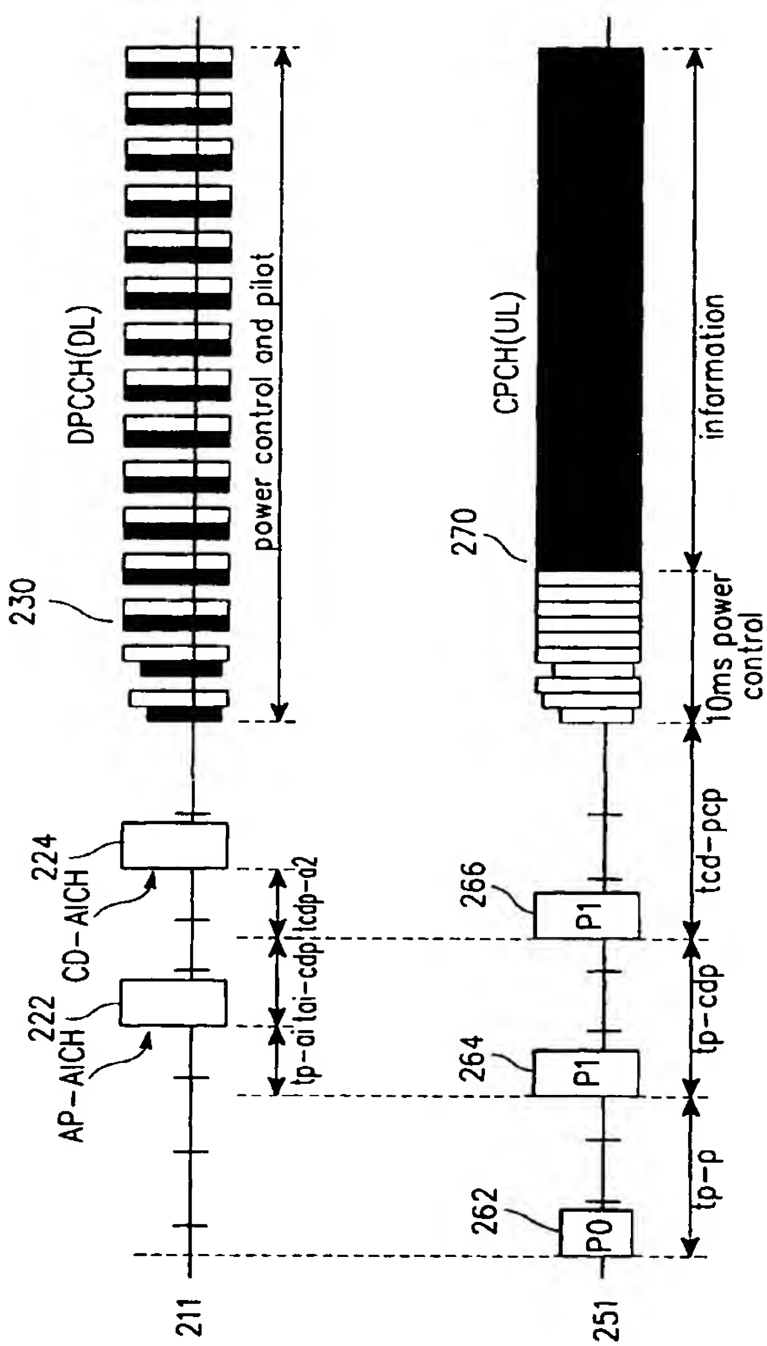

230
DPCCH(DL)
power control and pilot
224
CD-AICH
222
AP-AICH
tp-ai
tai-cdp
tcdp-a2
211
270
CPCH(UL)
information
10ms power control
266
P1
264
P1
262
P0
tcd-pcp
tp-cdp
tp-p
251

FIG.2

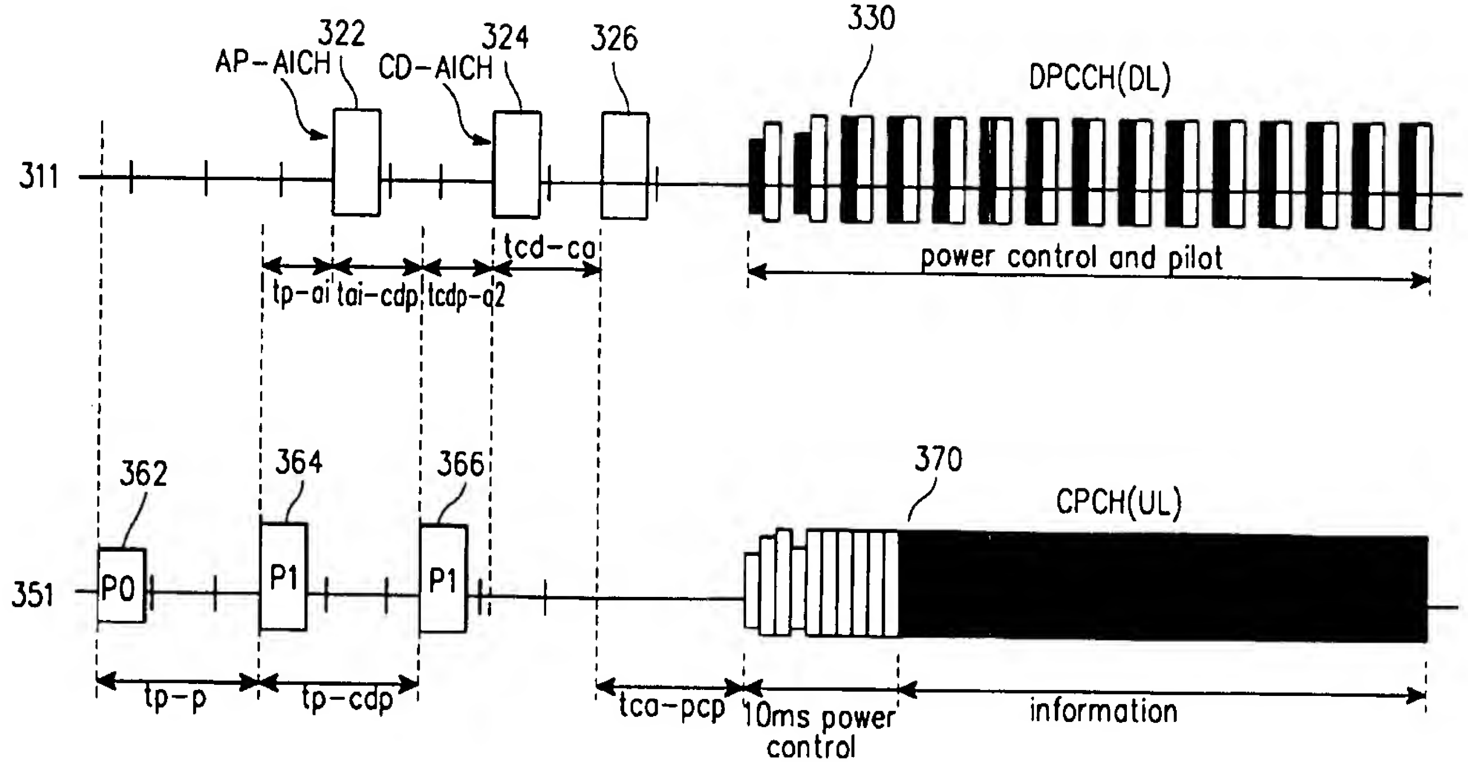

311
AP-AICH
322
CD-AICH
324
326
330
DPCCH(DL)
tp-ai
tai-cdp
tcdp-a2
tcd-ca
power control and pilot
351
362
P0
364
P1
366
P1
370
CPCH(UL)
tp-p
tp-cdp
tca-pcp
10ms power control
information

FIG.3

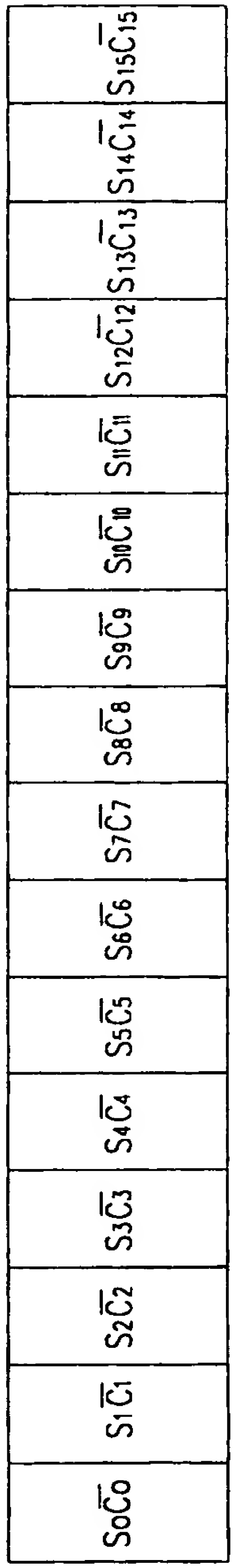

$S_0\overline{C_0}$
$S_1\overline{C_1}$
$S_2\overline{C_2}$
$S_3\overline{C_3}$
$S_4\overline{C_4}$
$S_5\overline{C_5}$
$S_6\overline{C_6}$
$S_7\overline{C_7}$
$S_8\overline{C_8}$
$S_9\overline{C_9}$
$S_{10}\overline{C_{10}}$
$S_{11}\overline{C_{11}}$
$S_{12}\overline{C_{12}}$
$S_{13}\overline{C_{13}}$
$S_{14}\overline{C_{14}}$
$S_{15}\overline{C_{15}}$

FIG.4

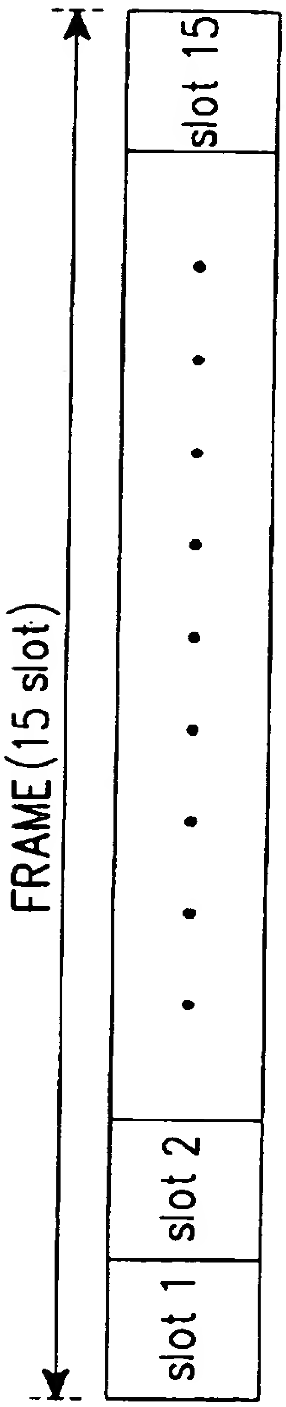


FIG.5A

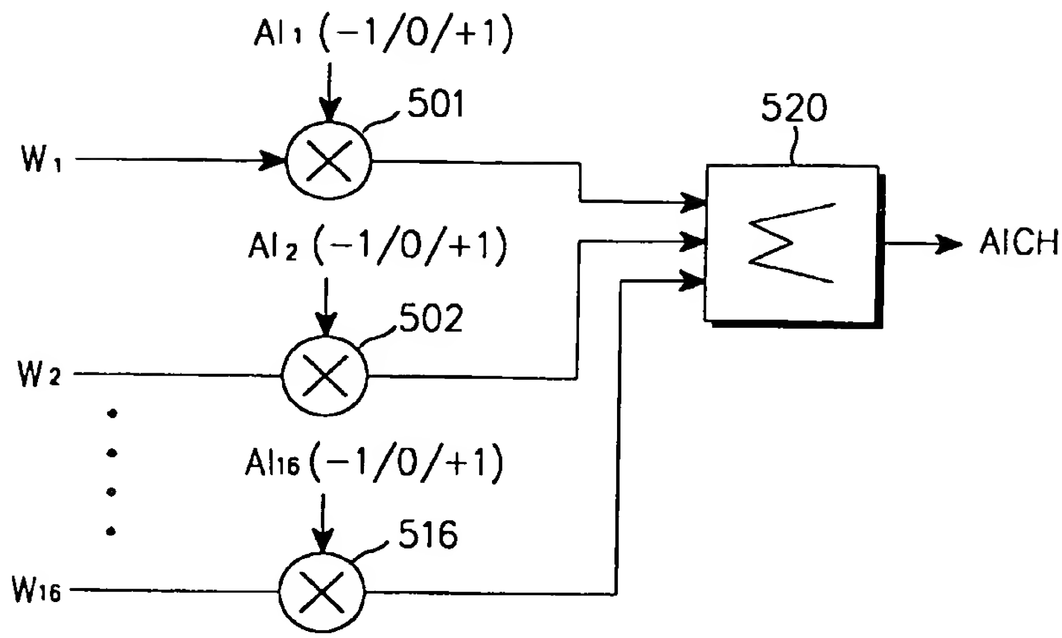


FIG.5B

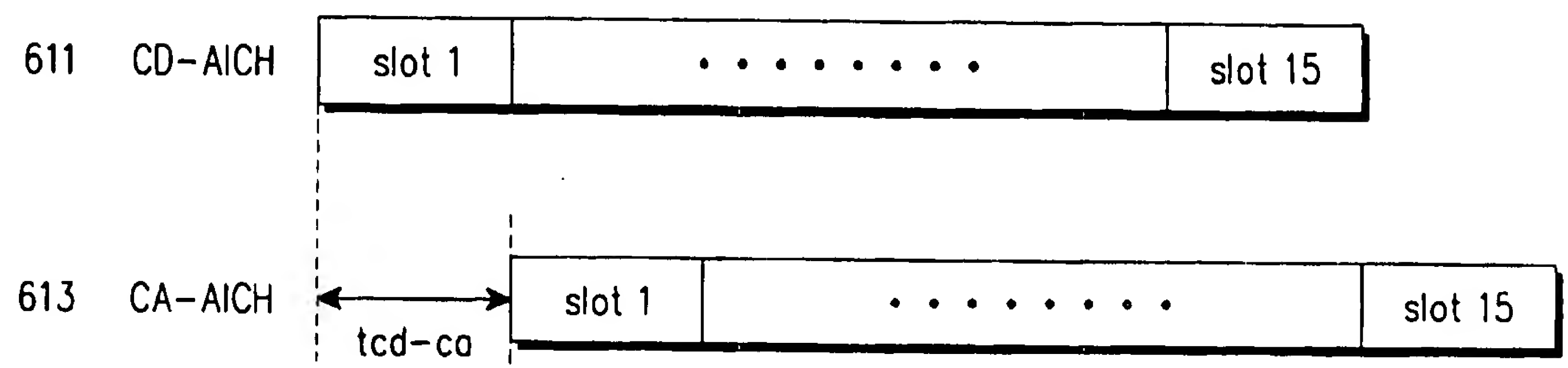


FIG.6A

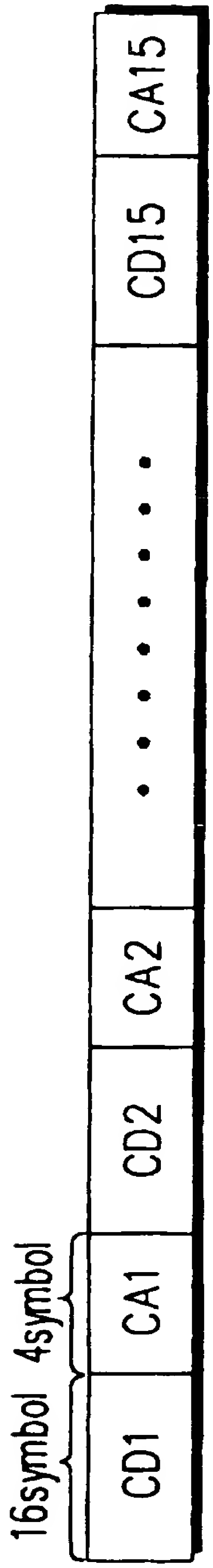


FIG.6B

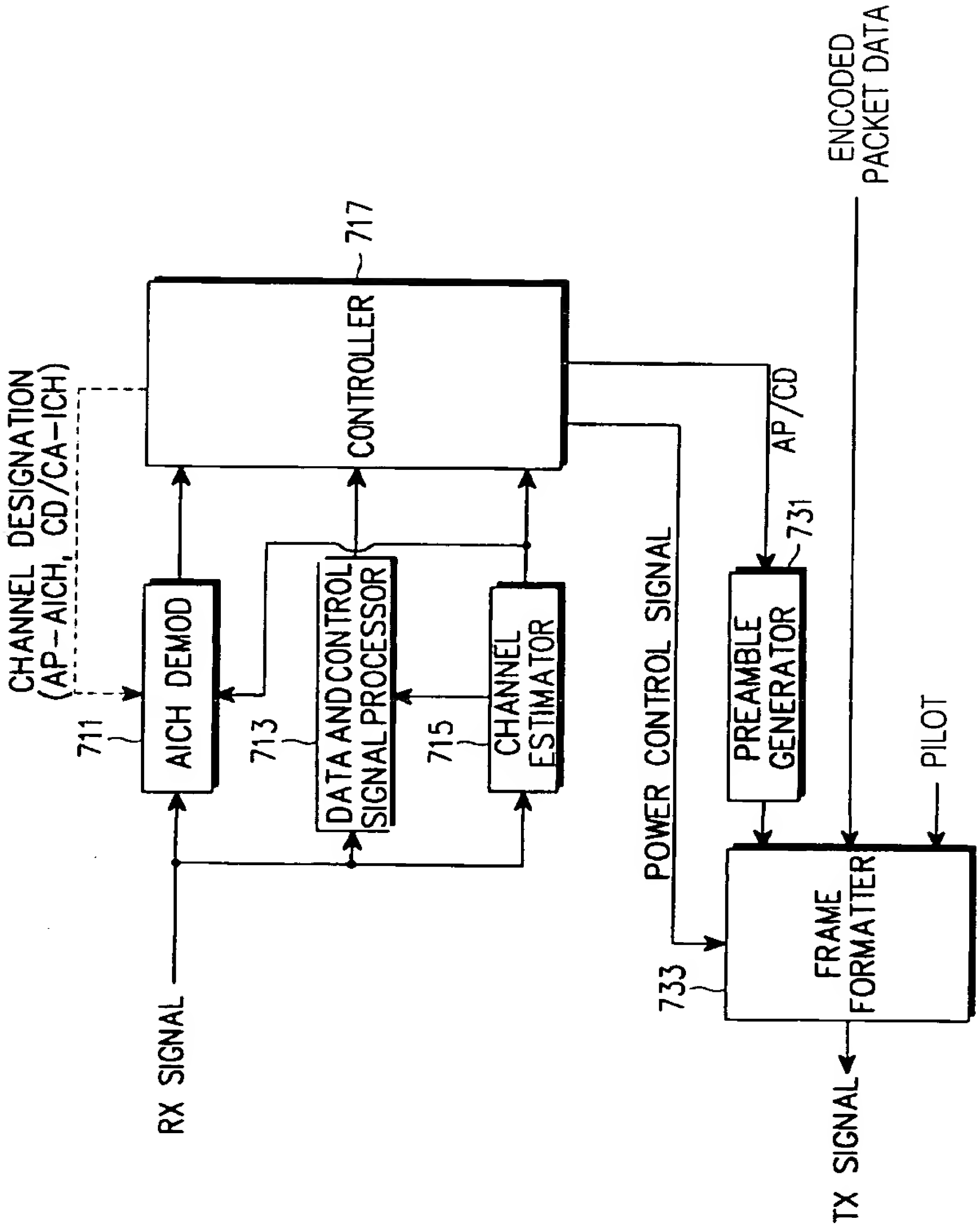

RX SIGNAL
711
AICH DEMOD
713
DATA AND CONTROL SIGNAL PROCESSOR
715
CHANNEL ESTIMATOR
CHANNEL DESIGNATION (AP-AICH, CD/CA-ICH)
CONTROLLER
717
POWER CONTROL SIGNAL
AP/CD
731
PREAMBLE GENERATOR
ENCODED PACKET DATA
PILOT
733
FRAME FORMATTER
TX SIGNAL

FIG.7

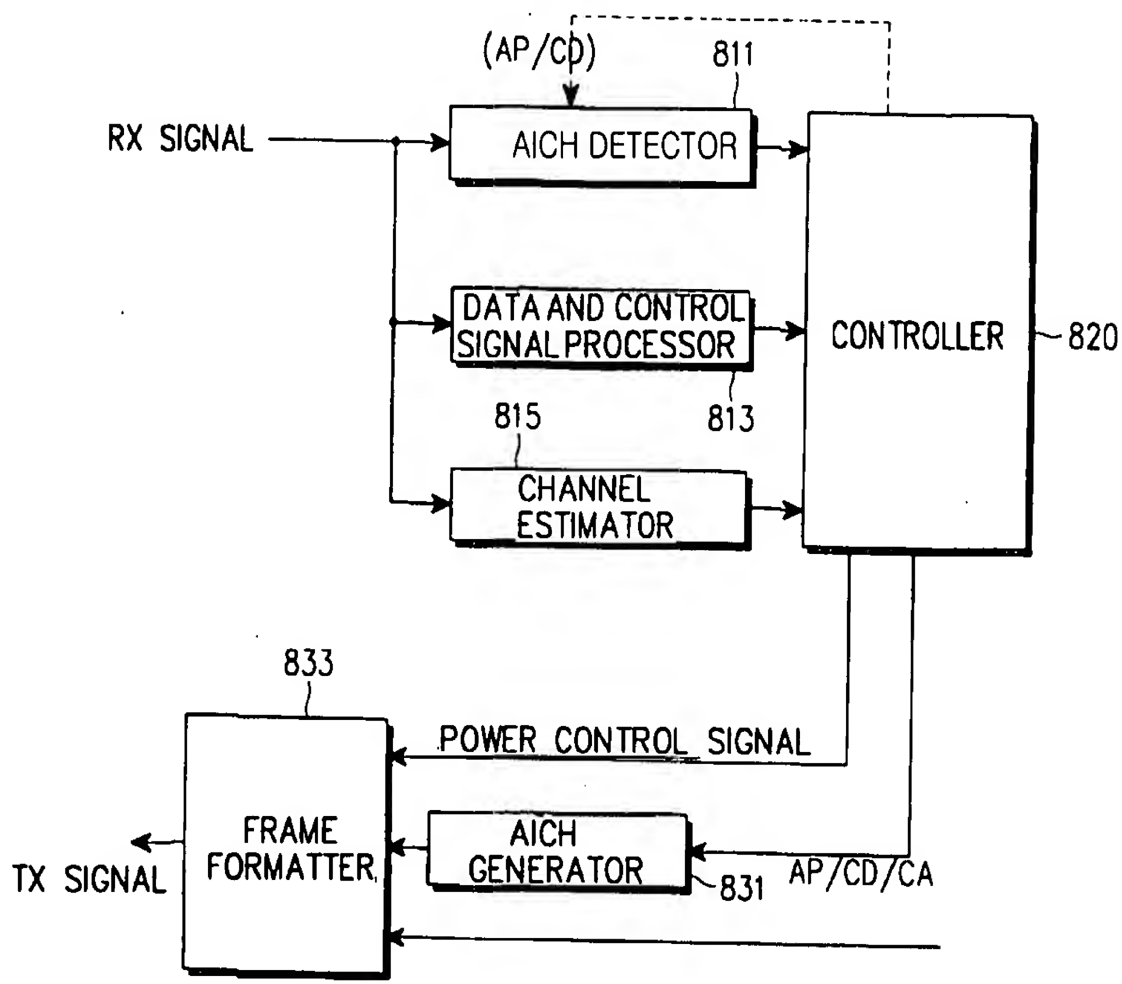

RX SIGNAL
(AP/CD)
811
AICH DETECTOR
DATA AND CONTROL SIGNAL PROCESSOR
813
815
CHANNEL ESTIMATOR
CONTROLLER
820
833
FRAME FORMATTER
POWER CONTROL SIGNAL
AICH GENERATOR
831
AP/CD/CA
TX SIGNAL

FIG.8

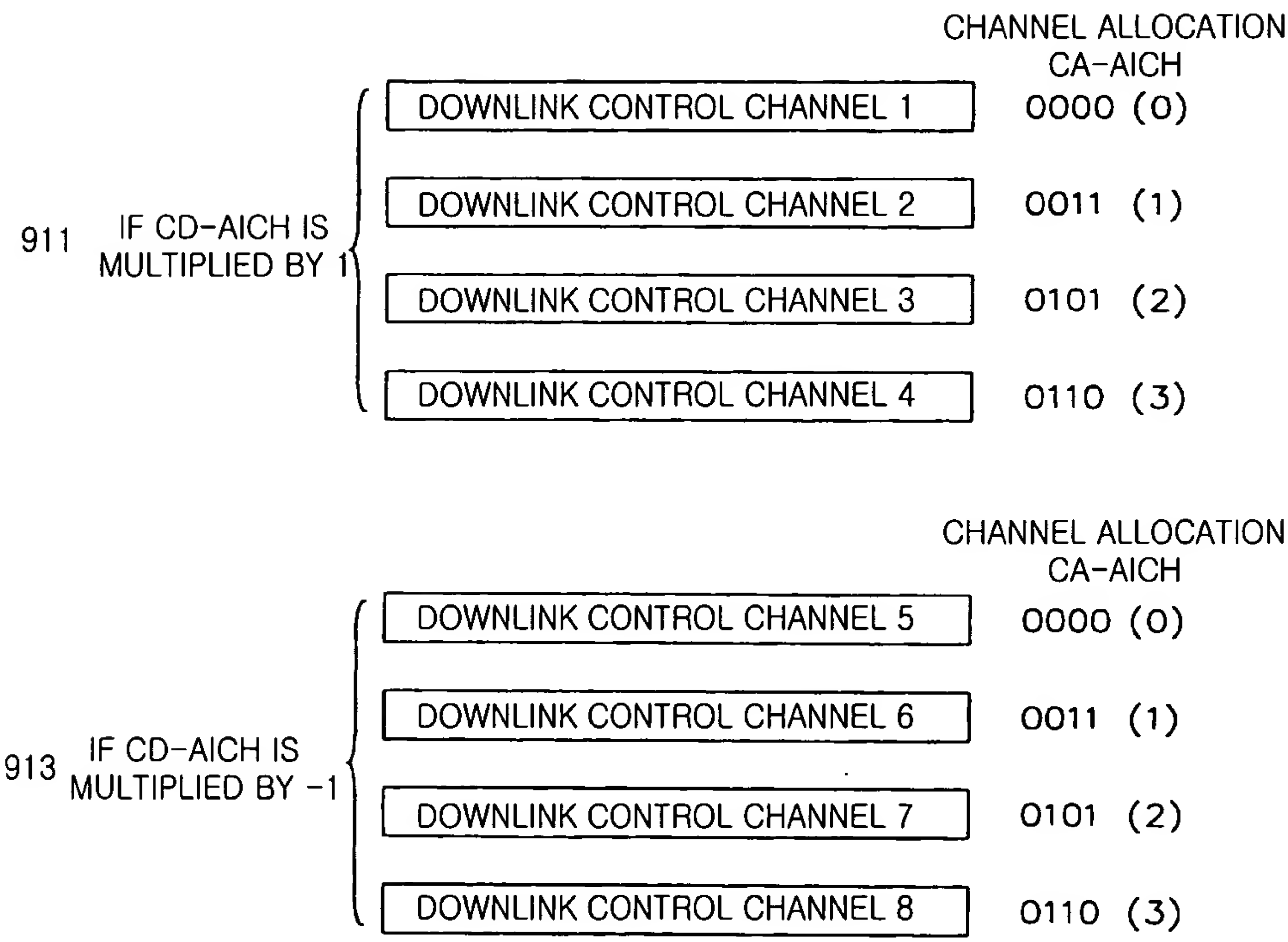

CHANNEL ALLOCATION
CA-AICH
DOWNLINK CONTROL CHANNEL 1
0000 (0)
DOWNLINK CONTROL CHANNEL 2
0011 (1)
911
IF CD-AICH IS
MULTIPLIED BY 1
DOWNLINK CONTROL CHANNEL 3
0101 (2)
DOWNLINK CONTROL CHANNEL 4
0110 (3)
CHANNEL ALLOCATION
CA-AICH
DOWNLINK CONTROL CHANNEL 5
0000 (0)
DOWNLINK CONTROL CHANNEL 6
0011 (1)
913
IF CD-AICH IS
MULTIPLIED BY -1
DOWNLINK CONTROL CHANNEL 7
0101 (2)
DOWNLINK CONTROL CHANNEL 8
0110 (3)

FIG.9

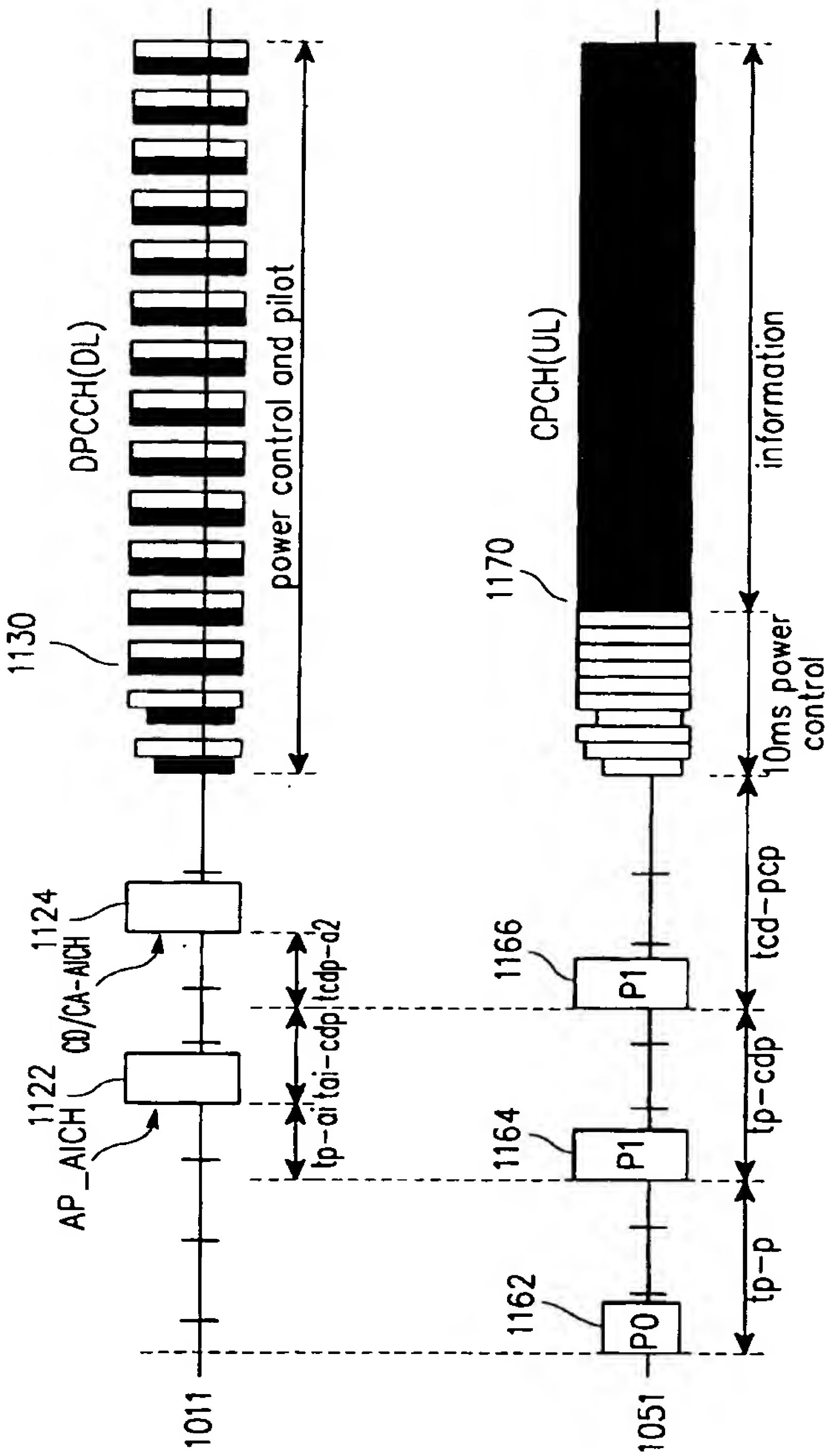

DPCCH(DL)
1130
power control and pilot
1124
CD/CA-AICH
1122
AP_AICH
tp-ai
tai-cdp
tcdp-a2
1011
CPCH(UL)
1170
information
10ms power control
tcd-pcp
1166
P1
tp-cdp
1164
P1
tp-p
1162
P0
1051

FIG.10

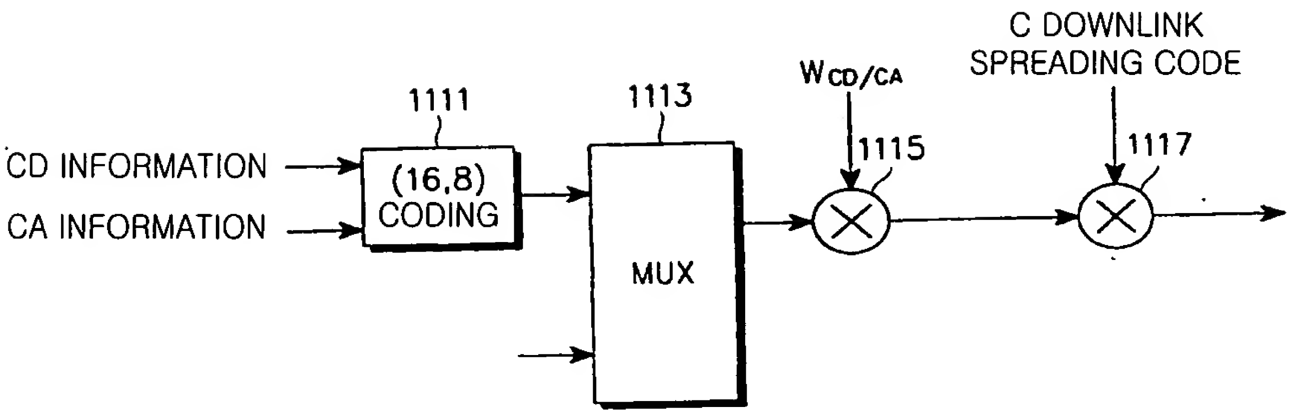

CD INFORMATION
CA INFORMATION
1111
(16,8) CODING
1113
MUX
W CD/CA
1115
C DOWNLINK SPREADING CODE
1117

FIG.11

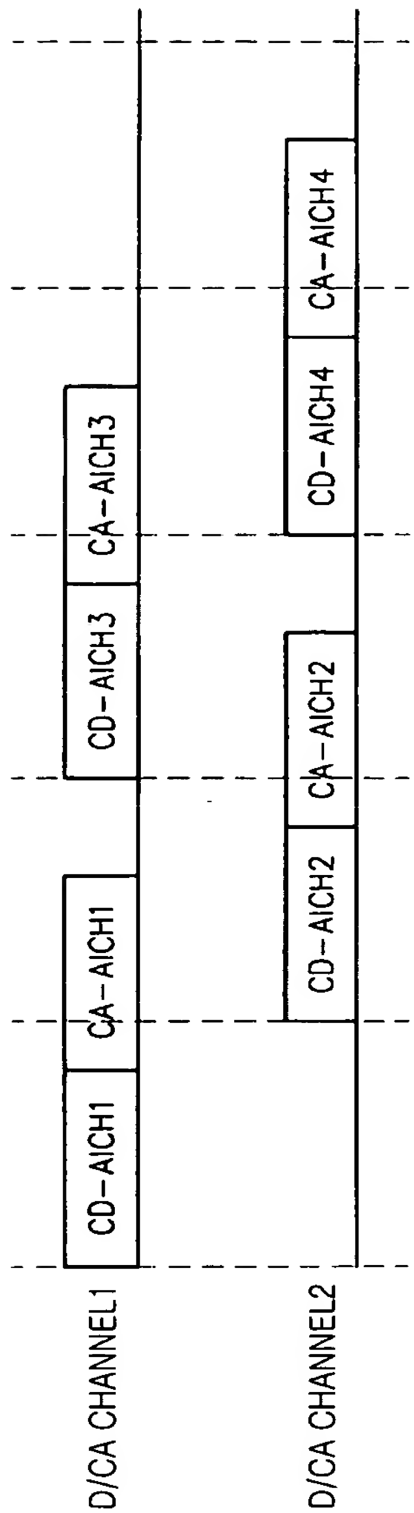

D/CA CHANNEL1
D/CA CHANNEL2
CD-AICH1
CA-AICH1
CD-AICH3
CA-AICH3
CD-AICH2
CA-AICH2
CD-AICH4
CA-AICH4

FIG.12A

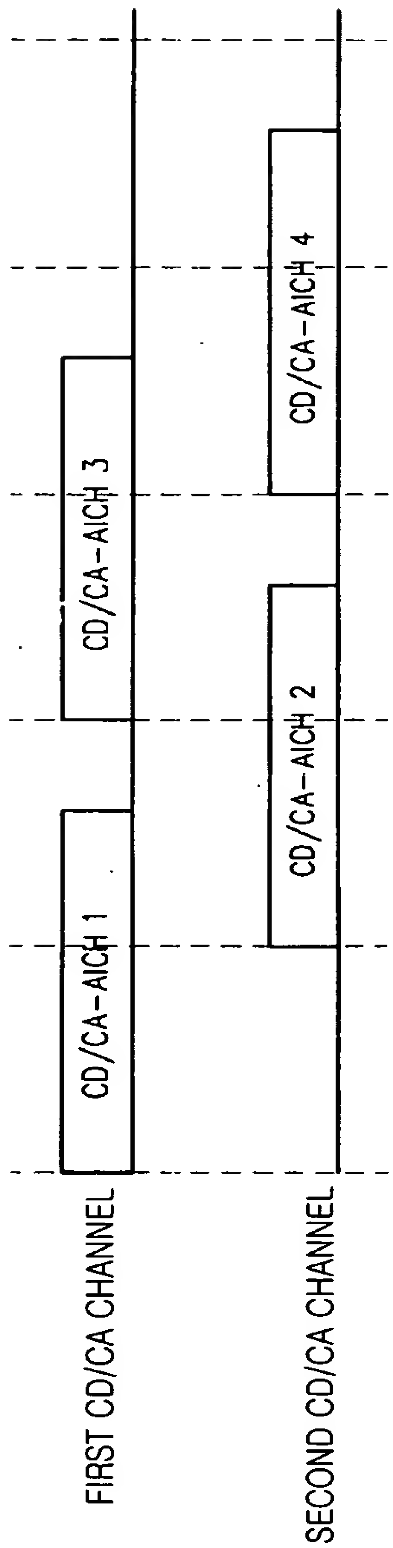

FIRST CD/CA CHANNEL
SECOND CD/CA CHANNEL
CD/CA-AICH 1
CD/CA-AICH 2
CD/CA-AICH 3
CD/CA-AICH 4

FIG.12B

Signature	Preamble symbols															
	P_0	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}
1	A	A	A	-A	-A	-A	A	-A	-A	A	A	-A	A	-A	A	A
2	-A	A	-A	-A	A	A	A	-A	A	A	A	-A	-A	A	-A	A
3	A	-A	A	A	A	-A	A	A	-A	A	A	A	-A	A	-A	A
4	-A	A	-A	A	-A	-A	-A	-A	-A	A	-A	A	-A	A	A	A
5	A	-A	-A	-A	-A	A	A	-A	-A	-A	-A	A	-A	-A	-A	A
6	-A	-A	A	-A	A	-A	A	-A	A	-A	-A	A	A	A	A	A
7	-A	A	A	A	-A	-A	A	A	A	-A	-A	-A	-A	-A	-A	A
8	A	A	-A	-A	-A	-A	-A	A	A	-A	A	A	A	A	-A	A
9	A	-A	A	-A	-A	A	-A	A	A	A	-A	-A	-A	A	A	A
10	-A	A	A	-A	A	A	-A	A	-A	-A	A	A	-A	-A	A	A
11	A	A	A	A	A	A	-A	-A	A	A	-A	A	A	-A	-A	A
12	A	A	-A	A	A	A	A	A	-A	-A	-A	-A	A	A	A	A
13	A	-A	-A	A	A	-A	-A	-A	A	-A	A	-A	-A	-A	A	A
14	-A	-A	-A	A	-A	A	A	A	A	A	A	A	A	-A	A	A
15	-A	-A	-A	-A	A	-A	-A	A	-A	A	-A	-A	A	-A	-A	A
16	-A	-A	A	A	-A	A	-A	-A	-A	-A	A	-A	A	A	-A	A

FIG.13

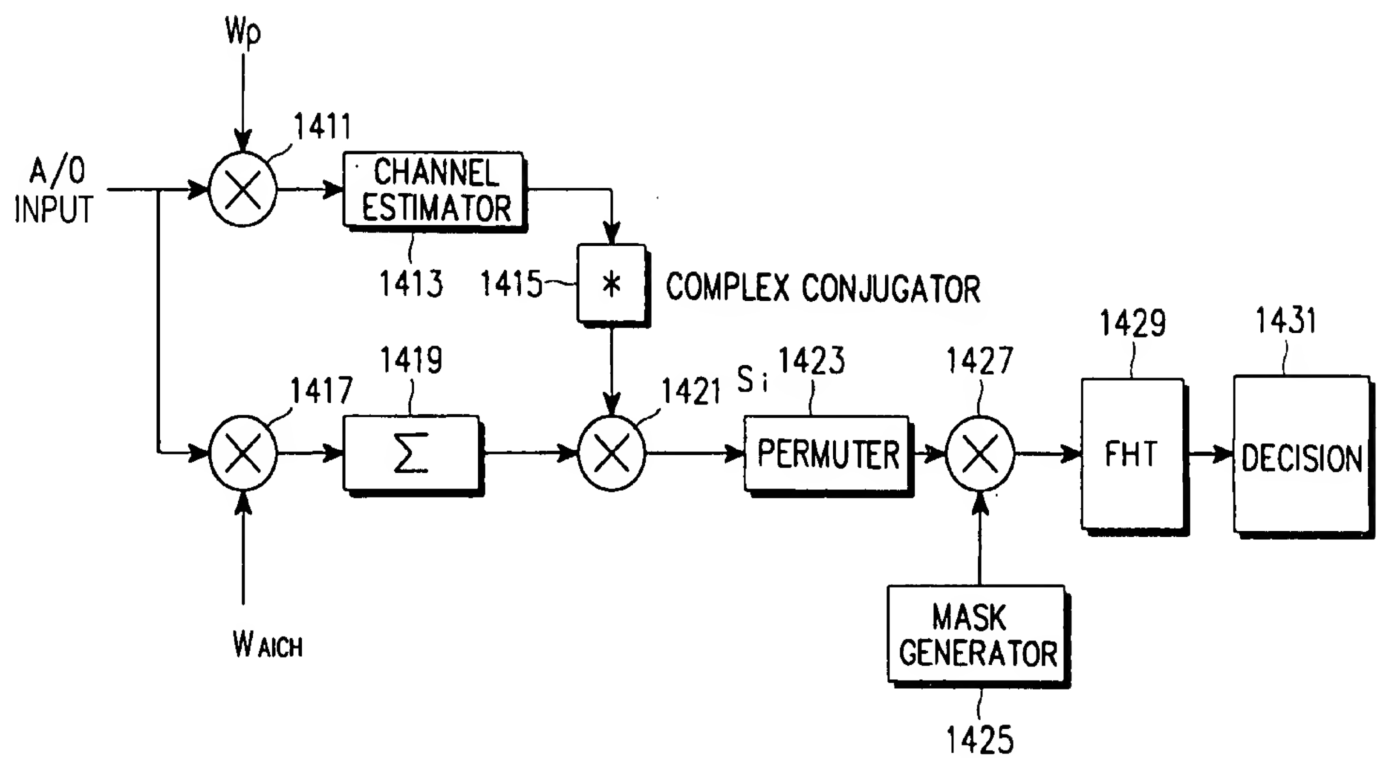

Wp
1411
A/0
INPUT
CHANNEL
ESTIMATOR
1413
1415
*
COMPLEX CONJUGATOR
1417
1419
Σ
1421
Si
1423
PERMUTER
1427
1429
FHT
1431
DECISION
MASK
GENERATOR
1425
WAICH

FIG.14

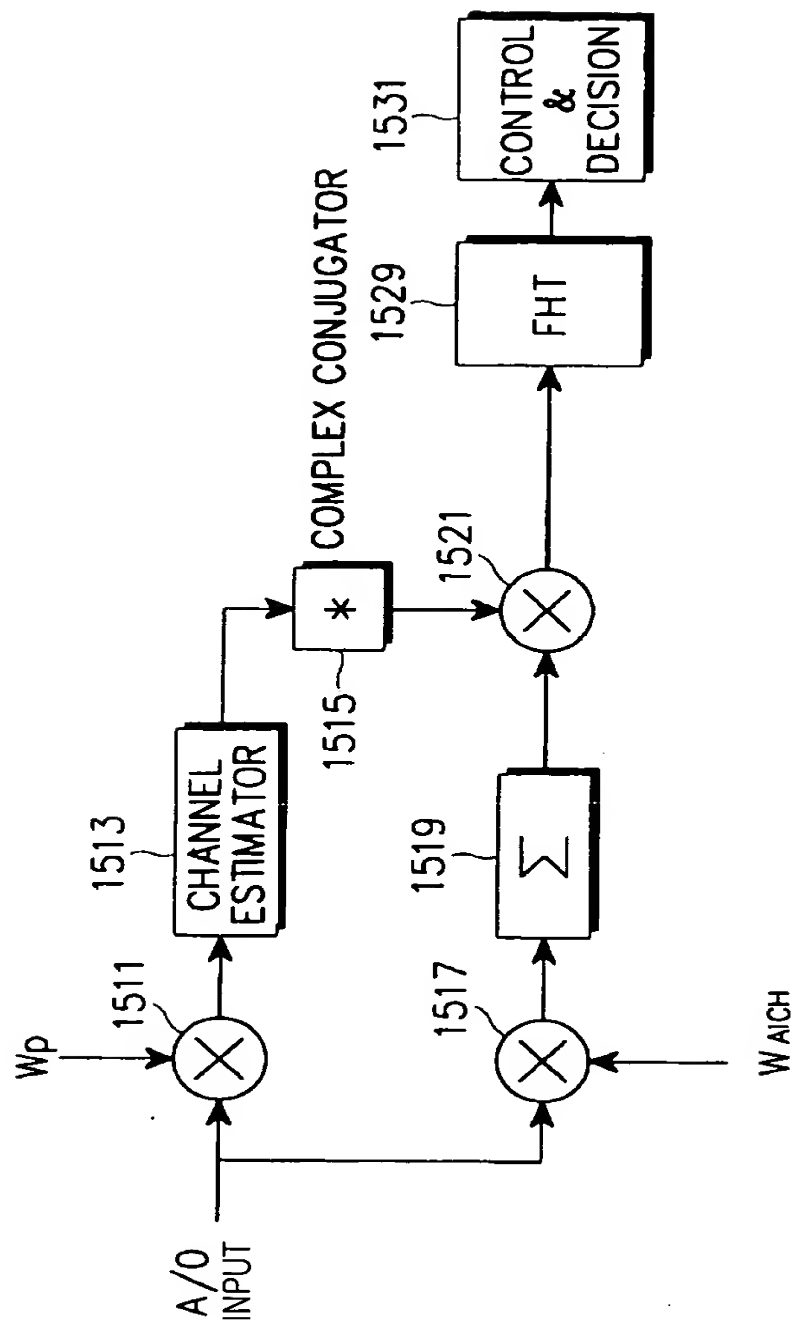
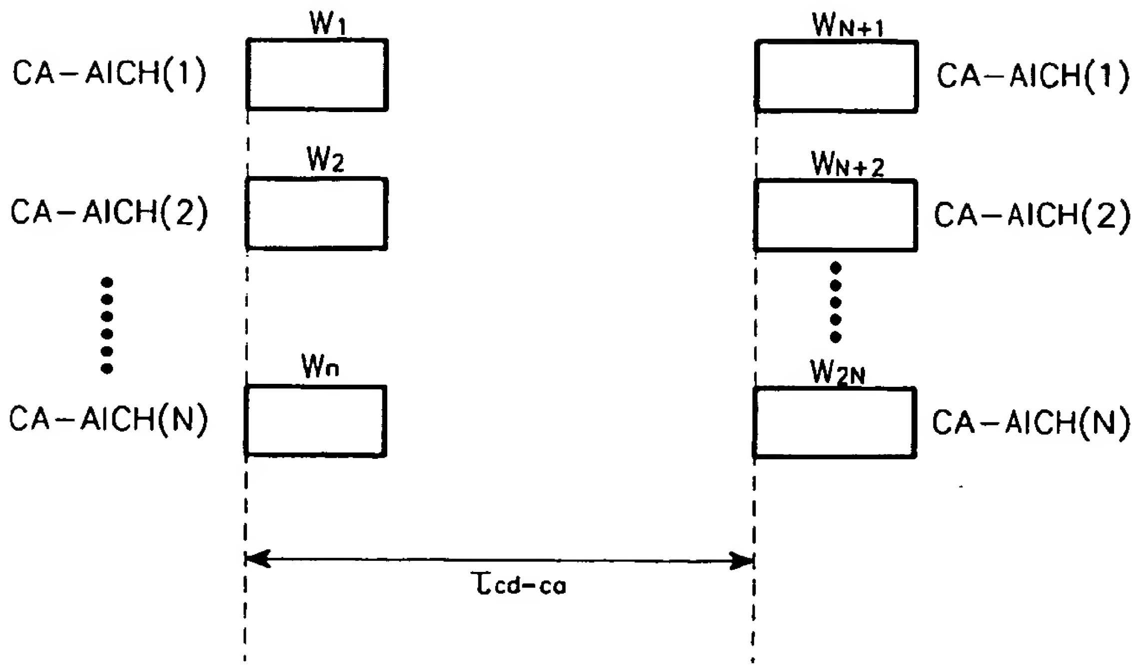

A/O INPUT
Wp
1511
1513
CHANNEL ESTIMATOR
1515
*
COMPLEX CONJUGATOR
1517
WAICH
1519
Σ
1521
1529
FHT
1531
CONTROL & DECISION

FIG.15



W_1
CA−AICH(1)
W_2
CA−AICH(2)
W_n
CA−AICH(N)
W_{N+1}
CA−AICH(1)
W_{N+2}
CA−AICH(2)
W_{2N}
CA−AICH(N)
τ_{cd-ca}

FIG.16

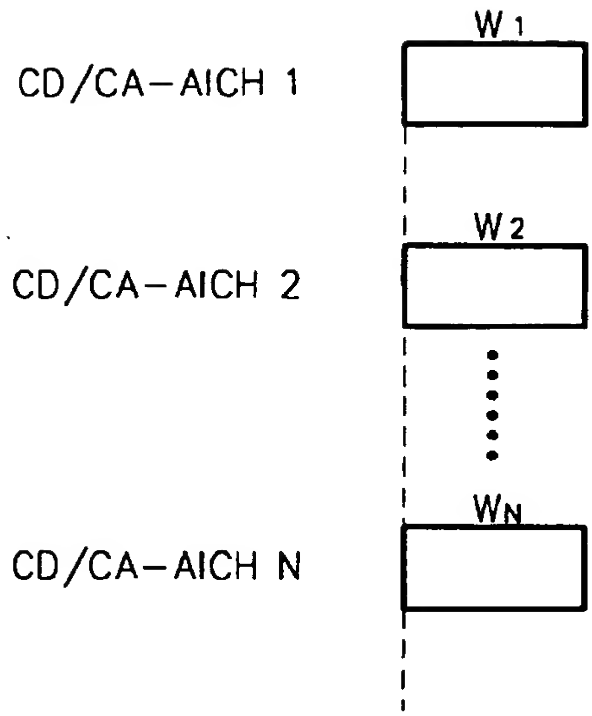


FIG.17